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OFFICERS AND COUNCIL OF THE BRITISH ASSOCIATION, 1949–50

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D. N. LOWE, O.B.E.

NEWCASTLE MEETING, 1949

FEW people think of Newcastle without conjuring up a mental image of Tyneside with its coal trade and heavy industry : some might even think of the inhabitants of these parts as a 'barbarous race.' Yet, at the end of the Association's meeting there in 1949, the President was able to say that he would always remember Newcastle as 'a city of flowers and kindly people' and if all such impressions, some unexpected, but all sincere, had been recorded, how glowing a record could have been written of the pleasure and profit of the visit to this district, so rich in historical, cultural and scientific interest, and characterised by hospitality which, if not without parallel, has never been surpassed in the long history of the Association.

The meeting was the 111th of the Association and the fifth in Newcastle, the most recent having been held in 1916 in less happy circumstances. But for the second world war, the Association would have met in Newcastle in 1940, an invitation for that year having been accepted and subsequently withdrawn by mutual agreement. Attended by 3,414 members, the 1949 meeting was the fourth largest held in the British Isles, the three larger meetings being in Manchester (1887), London (1931) and Oxford (1926), all of which were favoured by special circumstances. Two further points of interest in this connection were that the local registrations (about 1,800) broke all records and the number of student members (over 500) was exceptionally high.

All but two of the Sections were accommodated in King's College, the Psychology Section being housed in the Royal Victoria Infirmary and the Education Section in the Royal Grammar School, both within easy reach of the College. The Reception Room, administrative headquarters, press bureau and other offices were situated in the University Union and the special decoration and the appointments of the Reception Room were highly appreciated. On this occasion the administrative centre was separated from the social centre, the King's Hall in University College being appointed as a lounge. Information services, manned by students, were established in both centres. Corporation buildings were also freely and generously put at the disposal of the Association and the buildings of half a dozen institutions were open to members.

With a few exceptions, King's College was the point of departure and return of 47 general and 70 sectional excursions which, together, provided some 5,300 places on expeditions and visits of a wide range of interest. As has become usual at these annual meetings, the Association was favoured with a succession of brilliant September days.

The meetings were well reported in the press, by radio broadcasts and in technical journals. Up to the end of the year the Editors of *Nature* gave generously of their space each week for accounts of particular sessions and *Discovery* carried good reports in the issues for October and November. The October number of *The Advancement of Science* contained the full texts of the Presidential Addresses, the present number contains other material together with a record of the sectional transactions (p. 379) and a list of authors' references to publication of their papers or the substance of their contributions in other journals. The next number of *The Advancement of Science* will contain further reports on the proceedings and the present notes may serve as a general outline of the meeting.

Wednesday, August 31, 1949.

In the afternoon, meetings of Council and General Committee were held in King's College. The General Committee received and adopted the report of Council (p. 392) for the preceding year and the Treasurer's Statement and Accounts (p. 397) for the financial year ending March 31, 1949. Sir Harold Hartley was elected President for 1950 (Birmingham Meeting) and H.R.H. the Duke of Edinburgh President for 1951 (Edinburgh Meeting).

Otherwise members were engaged during the day in establishing themselves in rooms in the City, in the Colleges at Durham and at the coast and transacting business in the Reception Room. Among the literature issued to members on arrival was a Scientific Survey of North-Eastern England (204 pages). Specially prepared for the meeting by thirty resident experts, this Survey deals with the area of Northumberland and Durham and the northern part of the North Riding of Yorkshire. The quality of the writing and the production, the full documentation and the maps, including a coloured topographical map and an ingenious regional settlement

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Hospitality : Lord Ridley, Jas. Dickinson, J. E. Gregory.
Meeting Rooms : A. M. Milne.
Excursions : Dr. I. J. Faulkner, G. W. McKendrick, H. Walton.
Publications : Prof. G. H. J. Daysh, P. C. G. Isaac, Miss R. E. A. Allan.

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Recorder.—Dr. H. S. Rowell, O.B.E.
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Vice-Presidents.—Prof. H. G. Champion (*Chairman K* Forestry*), Prof. J. W. Heslop Harrison, F.R.S. Prof. J. R. Matthews, G. W. Temperley, Prof. M. Thomas, F.R.S.
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Vice-Presidents.—J. A. Hanley, His Grace the Duke of Northumberland, Major J. G. G. Rea, Prof. R. W. Wheldon.
Recorder.—G. V. Jacks.
Secretary.—Prof. H. G. Sanders.
Local Secretaries.—A. Main, Prof. H. Cecil Pawson.

CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES

President.—Dr. G. F. Herbert Smith, C.B.E.
Secretary.—Prof. W. T. Gordon.
Local Secretary.—Dr. Eveline Elliot.

map of the region, were greatly appreciated by the members and it is expected that the book, like others produced before the war in connection with meetings of the Association, will become a valuable standard work of reference.

The Inaugural meeting was held in the City Hall which was filled to capacity. The Inaugural meeting is always dignified but at Newcastle the sense of ' occasion ' was heightened by the brilliant pageantry of academic and civic ceremonial. For the first time in the history of the Association the Presidential Address was preceded by a graduation ceremony. At a Special Congregation of the University of Durham, the Vice-Chancellor, Sir James Duff, conferred on the President, Sir John Russell, the Honorary Degree of Doctor of Science. Thereafter, the Lord Mayor of Newcastle, Councillor A. Charlton Curry, welcomed the Association to the district in a short and charming address. Sir John Russell then delivered his Presidential Address on ' World Population and World Food Supplies ' which (again establishing new precedent) was broadcast direct by the B.B.C.

The President referred to the continuing growth of the world's population resulting from the application of scientific advances in the field of public health and social services which increased both the certainty and the length of life. He then surveyed the area of the earth's surface suitable for the production of food and dealt in detail with the ways in which science could contribute to the increasing of our food supplies by helping to solve the problems of intensive cultivation, the use of fertilisers, irrigation, pest and weed control and the combating of animal disease. After surveying new uses of science in food production with special reference to practical applications of knowledge discovered in fundamental investigations, he reached the conclusion that it would be possible to produce sufficient food to meet the needs of the world's growing population, but not by science alone. The possibilities of science were limitless, but food producers, in spite of a strong sense of individual responsibility, would need the encouragement of adequate appliances and incentives. Also, while foreseeable increases of food production might be more than ample to meet the needs of a population increasing at Western rates it could easily be outstripped by Eastern rates of population increase. If Western standards of living were desired in the East, Western restraints must be adopted. He finished, however, on a note of high optimism.

Sir David Rivett, late Chairman of the Australian Commonwealth Council for Scientific and Industrial Research, and a former President of the Australian and New Zealand Association proposed a vote of thanks with which this memorable meeting closed.

Thursday, September 1, 1949.

The distinction of being the reader of the first paper in the sectional proceedings fell to a local member, Prof. W. W. Rogosinski, whose paper on ' Volume and Integral ' was presented to the Mathematics Sub-Section, which began, in its traditional manner, half an hour before a general start was made.

Four sections had arranged to open with their Presidential Addresses. The Chemistry Section heard Sir Alfred Egerton deliver an address on " The influence of studies in combustion on the progress of chemistry ' which was followed by a discussion on the propagation of flame. Professor A. C. Hardy spoke to the Zoology Section on ' Zoology outside the laboratory.' The press seized and gave wide publicity to a brief statement he made of his belief that no one who examined the evidence for the existence of telepathy with an unbiased mind could reject its existence. This obscured the fact that his address was concerned mainly with the new and as yet inadequately recognised science of ecology. Mr. M. C. Burkitt's Address to the Anthropology and Archæology Section on ' The place of archæology in our national education ' had two main themes, one dealing with the similar pattern for the evolution of the stone industries in widely separated parts of the world and the other appealing for a place for the study of archæology in school curricula. Professor N. M. Comber was unfortunately prevented by illness from being present at the meeting and his Address on ' Farming, science and education ' was read for him by Professor R. W. Wheldon.

The first session of the Physics Section dealt with Soil Physics, a topic of basic importance for the production of food. The significance of new materials for the practice of engineering was the first subject considered by the Engineering Section and the information given in the papers was appreciated by engineers in industries likely to have applications for the new materials. In a discussion on the afforestation of moorlands, the Foresty Sub-Section considered problems of site preparation, drainage and use of fertilisers. The Physiology Section opened its programme with a discussion on adolescent nutrition at which the results of surveys of the feeding and health of public school boys and university students were presented.

The Sections of Botany and Psychology reserved their Presidential Addresses for the second half of the morning. Professor Lily Newton in her address to the Botany Section

on 'The utilisation of macroscopic marine algæ through the ages' gave an interesting history of the varied uses of seaweed. She dealt in some detail with the harvesting of certain seaweeds for the production of agar during the late war and with the present and possible future uses of seaweed as raw material of economic importance. The Presidential Address to the Psychology Section, by Sir Godfrey Thomson, entitled 'The nature of the mind's factors' was a critical examination of the methods of factorial analysis upon which intelligence tests can be based.

In the afternoon, delegates of Corresponding Societies heard Dr. G. F. Herbert Smith deliver his Presidential Address on 'The preservation of nature' which appears with a report of the meetings of the Conference of Delegates of Corresponding Societies on p. 332. Many of the sections spent the afternoon on excursions while the Sections of Engineering, Geography, Psychology and Zoology continued their programme of papers and discussion.

Two receptions, one for student exhibitioners and one for overseas visitors, were held in the late afternoon. At the first reception, held by kind invitation of the Lord Mayor, in the Laing Art Gallery, student exhibitioners from thirty-five Universities and University Colleges, met Sir John Russell, the Lord Mayor, a number of Sectional Presidents and each other at an informal tea-party. This was arranged to provide an early opportunity for those selected scholars to make contacts which would add to the benefits of attending the meeting. The second reception was held by invitation of the British Council at their House in Newcastle, when overseas visitors were entertained at a sherry party where they met senior members of the Association and prominent citizens of Newcastle.

In the evening the Lord Mayor and the Lady Mayoress (Councillor Mrs. Grantham) received the members as guests at a Civic Reception. Members were received in the Dental School and passed on either to the Old Assembly Rooms for dancing and refreshments or to the City Hall for a concert at which the Newcastle Bach Choir, the Felling Male Voice Choir and individual local artistes took part in a programme of a very high order. Refreshments for those attending the Concert were served in St. George's Hall.

Friday, September 2, 1949.

On this morning the programmes of four Sections opened with Presidential Addresses. The Astronomer Royal, Sir Harold Spencer Jones, addressed the Physics and Mathematics Section on 'Some developments in astronomical instruments.' He surveyed the history of the major astronomical instruments and described the current trend of design. The address was followed by three papers dealing with contemporary work on astronomical instruments. In his Address to the Geography Section on 'The planning of land use,' Professor L. Dudley Stamp dealt with the problem of determining the optimum use of land in the face of several conflicting claims. He expressed his concern at the danger of the expansion of land developed for towns, villages and roads leading to 'new towns to starve in.'

Sir Alexander Gray, doyen of British Professors of Economics, delivered his Address on 'Economics: yesterday and tomorrow' in which he began by discussing the continually changing view of what economics was supposed to be, with particular reference to the disappearance of barriers between economics on the one hand and, on the other, politics, psychology, jurisprudence, ethics and theology. He then went on to discuss the economic climate of the age of the Welfare State analysing (with the shrewd comment and racy wit which marked the whole address) the relative values of compulsion and of incentives in a free society. In his address to the Education Section on 'The widening scope of the study of education,' Sir Fred Clarke developed the thesis that we were reaching a concept of education for which little or nothing in the life of society is wholly irrelevant.

The Chemistry Section held a symposium on 'The nitrogen cycle in nature,' in which two of the papers were by distinguished overseas visitors. Two eminent foreign oceanographers contributed main papers at a discussion on 'The geology of the ocean floor' held by the Geology Section on the same morning. Three Sections, Zoology, Botany and Agriculture combined for a discussion on 'Agricultural ecology'; the Physiology and Psychology Sections met together for a symposium on 'The relation of brain to mind'; and a session on various aspects of ground subsidence, arranged by the Engineering Section, had a wide appeal, interesting not only engineers but geologists, farmers and the public.

In the afternoon a symposium on 'Field Study Centres,' at which the wardens of various centres described the work done in their several regions was held by the Sections of Geology, Zoology, Geography, Anthropology and Botany. The Education Section spent the afternoon discussing the objectives in the education of Colonial peoples.

The work of the N.E. Region of the Central Council for Physical Recreation was

illustrated at a demonstration given in the evening at the Medical School. The programme included rhythmic movement, weight training, recreational physical training, and dances both modern and traditional.

In the lecture theatre of the Newcastle Literary and Philosophical Society, which was packed for the occasion, Professor Hans Pettersson delivered an illustrated Evening Discourse on ' Exploration of the ocean floor.' Introduced by Professor L. Dudley Stamp, the lecturer, who was leader of the Swedish Deep Sea Expedition, described the voyage of the *Albatross* in five oceans, gave an account of the work on the ship and a preliminary report on the results of working up the material in Sweden. The text of the discourse was published in *Nature* on September 17, 1949, without, of course, the charm and humour of the lecturer and the excellence of the illustrations which captivated the audience.

Four Sections held dinners on this evening.

Saturday, September 3, 1949.

For many, Saturday was a day of rest or other individual relaxation but the majority of the members took part in organised excursions and visits, one of the most memorable of which was a visit of some 200 members by special train to the works of I.C.I. at Billingham.

In the evening, at a meeting which was open to the public, over 1,000 people assembled in the City Hall for an international discussion by experts on the theme of Food and People. The session is fully reported on p. 362.

Sunday, September 4, 1949.

A welcome to members was offered by all Churches in the City and at Durham. An official service was held at Morning Prayer in the Cathedral when the Lord Bishop of Newcastle preached the Sermon. The service was attended by senior representatives of the City, the University and the Association who formed an impressive and colourful procession.

Apart from excursions, the only other official item in the Programme was an evening address. Professor A. D. Ritchie gave a philosophical discourse on The Science of the Living and the Lifeless in the lecture theatre of the Literary and Philosophical Institute which was again filled to capacity.

Monday, September 5, 1949.

When Sections reassembled on Monday morning three Presidential Addresses were delivered. Professor W. J. Pugh gave his address on ' Recent work on the Palæozic Rocks ' to the Geology Section ; Professor R. A. Peters delivered his Address to the Physiology Section on ' The Cell,' which was followed by an all-day discussion ; Sir Arthur Fleming dealt with ' The bridge between science and industry ' in his Address to the Engineering Section. This last Address was followed by a discussion to which Sir Andrew McCance and Sir Henry Tizard contributed. The Forestry Sub-Section heard Professor H. G. Champion, give the Chairman's Address on ' The future of our new forests,' which is printed on p. 319.

Papers on fundamental particles read to the Physics Section summarised the present state of knowledge on the particles of the atomic nucleus. In the second half of the morning the Section transferred its interest from the atom to the universe and received three papers on radio-astronomy. Recent work on fluorine and its compounds, both organic and inorganic, was described at the morning session of the Chemistry Section. The Sections of Botany and Zoology joined in two concurrent discussions, one on river pollution and the other on the artificial production of mutations. The Psychology Section discussed the results of studies of the quality of the population in which the possibility of a decline in the intelligence of the population was considered. A report of this discussion appears on p. 357. To the Anthropology Section, in a paper on further applications of the fluorine test, Dr. K. P. Oakley made the first announcement of the results of chemical tests on the Piltdown skull which resolved a long-standing difference of opinion as to the age of the skull. This paper, and a supporting note by Dr. Robert Broom, are summarised on p. 343. In a paper to the Agriculture Section on the development of domestic beef production, Professor M. M. Cooper expressed the view that British agriculture was by no means as efficient as it could be ; this statement stimulated lively discussion which was continued later in the daily press and in farming journals.

In the afternoon of Monday the Conference of Delegates of Corresponding Societies held its second meeting, of which a report begins on p. 332. Seven Sections met to receive papers, the sub-section of Forestry joining its parent Section, Botany, for a discussion on ' Forests and man ' at which papers on historical and contemporary aspects of the inter-relationship were given. This discussion was followed by a semi-popular lecture by Professor F. E. Fritsch on ' Algæ and calcareous rocks.' In the early evening Dr. A. L. Whiteley gave a lecture of general interest, on ' Electronics in war and peace.' This was one of three lectures arranged by the Engineering Section for the public as well as members.

Six Sections held dinners on this evening, while members of the Engineering Section were entertained at a Conversazione by the N.E. Coast Institution of Engineers and Shipbuilders.

The third Evening Discourse was delivered on Monday. In the absence of Dr. Julian Huxley who was unable to be present to speak, as announced, on Science and Reality, Dr. George Taylor, deputising at short notice, addressed an appreciative audience of 500 people on Plant Hunting in Tibet. The lecture was illustrated by exquisite colour transparencies of alpine plants and by colour films which included a rare one of ceremonies at Lhasa.

Tuesday, September 6, 1949.

Having received the 54th Report of the Committee on Seismological Investigations (see p. 375), the Physics Section proceeded to a discussion on geophysics. The Chemistry Section held a symposium on chemistry and the food supply which consisted of an introductory paper and five papers on specific uses of chemicals in agriculture. It is intended that a report of this interesting session will appear in the next issue of *The Advancement of Science*. While the Chemistry Section were discussing factors affecting food supply, Dr. K. G. Fenelon was giving a paper to the Economics Section on the sources and volume of Britain's food supplies; this paper will be found on p. 311. The Engineering Section devoted its morning to papers by four young engineers on such varied subjects as the use of coke, the settlement of structures on clay foundations, the jet-propulsion of ships and electrical methods of inducing and detecting vibrations.

The Agriculture Section joined in two discussions, one with the Physiology Section on microbial digestion in the alimentary tract and one with the Forestry Sub-Section on forestry and hill farming. The Botany Section held two concurrent sessions, one consisting of papers on plant physiology and one of papers on marine algæ.

The afternoon was devoted to excursions by many of the Sections, while the Sections of Zoology, Economics, Anthropology, Psychology and Education held meetings. The Education Section discussed the report on 'Science in Adult Education' prepared by a joint committee of the Association and the National Institute for Adult Education. The report, which was published in the July, 1949, issue of *The Advancement of Science*, was introduced by Mr. W. O. Lester Smith, Chairman of the committee which had prepared the report, and several members of the committee were among the speakers who contributed to the discussion. In the early evening, under the auspices of the Engineering Section, Dr. J. C. Weston gave a public lecture, illustrated by a sound film, on 'Heating research for houses.'

On this evening, the Natural History Society of Northumberland, Durham and Newcastle upon Tyne entertained 250 members of the Association at a conversazione in the Hancock Museum. At an earlier hour on this last evening, the President and General Officers, members of Council and Presidents and Recorders of Sections, entertained to Dinner in the University Union all overseas guests of the Association and principal representatives of the Committees responsible for the local organisation of the meeting.

Wednesday, September 7, 1949.

Only the Sections of Physics, Geology, Geography, Physiology, Psychology and Education held meetings on the last morning. The programmes of Geology and Geography Sections contained separate papers on diverse subjects, the remaining Sections having arranged symposia: the Physics Section on new optical methods for studying micro-structures, at which Dr. E. W. Taylor showed a film explaining the functioning of a phase contrast microscope and Professor S. Tolansky demonstrated the uses of multiple-beam interferometry; the Physiology Section had a well attended meeting at which recent investigations into the effects of folic acid and vitamin B_{12} on anaemia were discussed; the Psychology Section had papers on psychology and teaching; the Education Section considered the position of primary schools in the educational system.

A film show, arranged by the University Films Council, attracted many members to fill the theatre at Newcastle. The programme included films on crystal growth, soil erosion, water conservation and the making of sulphuric acid.

The meeting closed, as it began, with business meetings of the Council and of the General Committee which, meeting at noon, passed with acclamation the following resolution:

'At the end of an unusually successful meeting in Newcastle upon Tyne, the General Committee resolves as follows:

(i) To place on record the warmest thanks of the Association for the hospitable reception afforded by the City of Newcastle and the University of Durham. The generous co-operation of the Lord Mayor of Newcastle, the Vice-Chancellor of the University and the Rector of King's College, and the unusually thorough preparations made by the local officers and Committees, have been deeply appreciated by all the members of the Association and have contributed in high measure to the undoubted success of the meeting.

(ii) To thank the City, the University and the University Union most cordially for the unsparing use of buildings and equipment and the never failing kindness of their staff.

(iii) To thank also the scientific, educational, commercial and industrial institutions and all private hosts in Newcastle and neighbourhood for facilities and hospitality so generously provided for meetings, visits and the entertainment of visitors from home and overseas.

(iv) Finally, to record with special gratification the unusually high local membership of the Meeting.'

BRITAIN'S FOOD SUPPLIES[1]

BY

DR. K. G. FENELON

THE term food covers a multitude of commodities and though one man's food may not exactly be another man's poison, there are great differences both qualitatively and quantitatively in the food and dietary habits of different peoples. Popular tradition, for example, associates roast beef with Old England and before the days of rationing the foreigner marvelled at the Englishman's bacon and eggs for breakfast. To-day so diligently have our tourists pursued grilled steaks that it is sometimes difficult to persuade one's host in another country that one could possibly fancy any other dish.

Other nations—other customs. Rice is the staple diet of the peasant in many though not in all parts of the Far East. The goulashes and similar traditional dishes of Continental Europe probably had their origin in the need of making the best use of the poorer quality joints and of making the meat go further; much less meat being consumed per head in most European countries than in Great Britain. In Ireland a combination of climatic, historical and economic conditions led to the ascendancy of the potato in the eighteenth century and Arthur Young who toured the island in 1776, quoted an astonishing consumption figure of 8 lb. of potatoes per head per day spread over the family. According to Salaman a figure of 12 lb. a head a day for adults was exceeded in the following century. In Scotland the potato never attained the same pre-eminence, the Scotsman, despite the jibe of Dr. Johnson, remained faithful to his oatmeal and also to his kail. In almost every country there is to be found some favoured food which has attained an important position in the diet of the particular nation either through choice or necessity. By way of illustration there may be mentioned boiled fish in Scandanavian countries, meat in Argentina, Sauerkraut in Germany, spaghetti in Italy, seaweeds in Japan or bamboo shoots in China. Quantitatively also there are great differences between nations as is evident if we compare say Northern European countries with those of South-Eastern Europe, or the U.S.A. with China.

In general, national diets are determined by a variety of factors among which tradition, habits, natural resources, climate and incomes are important.

Apart from national differences in diet, regional and class differences are also apparent. In Great Britain as in certain other countries these regional variations are evident from the traditional names of choice varieties of food associated with definite localities. To mention but a few at random—and I have no doubt that each local patriot will be able to add to the list—we may note Yorkshire pudding, Wensleydale cheese, Devonshire cider, Cornish pasties, Goosnargh cakes, Lancashire hot-pot, and Welsh mutton.

The trend is nowadays towards a greater degree of dietary uniformity throughout the country and in the process unfortunately some of the best local traditions of food preparation or usage may be lost. Home-baking and local cheese-making are cases in point. War-time shortages and housekeeping difficulties have accelerated a process which was well under way when William Cobbett thundered against the decay of home brewing.

Class differences are also important though much less so than in the past. Rationing and the redistribution of income, have had a marked effect in narrowing these differences. Nevertheless differences in family income, education, tastes and habits even to-day result in considerable variation in the kind of foods consumed by the different classes in the community.

International Comparison.

Differences in the pattern of national diets make it difficult to compare one country with another. The best method so far evolved is that of the Food Balance Sheet in which statistics of food production and of trade in food commodities for a given year are put together to arrive at the total supply. The uses to which this total supply is put are then set out on the other side of the Balance Sheet under various headings such as manufacturing usage, animal food, seed, export and finally human food. The Food and Agricultural Organization of the United Nations (F.A.O.) has recently published Food Balance Sheets for 41 countries covering a representative pre-war period and the year 1947/8. The

[1] Paper delivered to Section F (Economics) at the Newcastle Meeting on September 6, 1949.

results, however, are still very tentative and F.A.O. emphasizes that many of these studies have been based on such information only as was readily available to it and that for many countries the Balance Sheets need further elaboration and refinement. For those countries where the statistical coverage is still of a rudimentary nature the Balance Sheets are at best only an 'informed' estimate. They are useful in comparing the food position of one country at different dates, but the greatest caution is necessary when using the figures for international comparison.

Such comparisons, however, are frequently made and many exaggerated statements are current, for example in comparisons of Britain's diet with those of the countries of Continental Europe. It is necessary in making such comparisons that the matter should be seen in correct perspective. Before the war each European country had developed its own traditional pattern of food consumption. Generalization therefore is not easy but, broadly, European countries fell into four well-defined groups, namely :

(1) The British Isles, Denmark, Sweden, Switzerland.
(2) Western and Central Europe, Finland and Norway.
(3) Mediterranean and Southern Europe.
(4) Eastern and South-Eastern Europe.

Before the war the best fed European countries were those in the first group. Although many other countries in the second group enjoyed total food consumption almost as high as those in the first group, their diets were rather less attractive by our standards as they relied far more on cereals or potatoes than we did ; the proportion being nearly one-half as compared with our third. Consumption levels in the third and fourth group were in no way comparable to our own. Calorie intakes were lower and as much as 60 to 75 per cent. of the total was provided by grain and potatoes.

Our calorie intake to-day is almost equal to what we had pre-war and only Denmark, Sweden, and possibly Switzerland have much more. To achieve this, however, we have greatly increased our consumption of cereals and potatoes. In short, Britain has maintained her pre-war average calorie intake better than most European countries have done but at the expense of departing further from her pre-war pattern of diet. We are eating less meat *per capita* than Denmark, Switzerland, France and Sweden, less fats and oils than Norway, Sweden or Belgium and less sugar than Sweden. World shortage in the preferred foods has hit us more hardly than other countries because we rely more heavily upon imported food and feedingstuffs. In meat and bacon for example, most other European countries were largely self-sufficient, and as they have rebuilt their war-damaged economics, they have automatically improved their food position. Great Britain on the other hand even before the war was finding it difficult to maintain a balance of payments which would enable her to obtain all the food and raw materials she needed. The war vastly accelerated the loss of her overseas investments and economic, political and financial changes throughout the world have intensified the difficulties which face a highly industrialized nation of some 50 million people, four-fifths of whom live in urban areas, in finding food imports overseas.

Great Britain has been for many years and still is the world's greatest importer of food and animal feedingstuffs. Before the war no less than a quarter of the annual value of world trade was accounted for by trade in food and feedingstuffs and of this the United Kingdom's share was about 40 per cent. The United Kingdom took the bulk of a great many foods entering world trade and thereby influenced not only trade in these commodities but the production, price and the very livelihood of whole peoples and their states. Every important food exporting country looked to Britain as a market for its products and our imports ranged through the alphabet from Almonds to Yeast or from Algerian wine to Zanzibar spices. In the official Import List over 580 separate items relating to food are included.

In the face of such a diversity of foods it is impossible in the time available to do more than examine the position of the main foodstuffs in broad outline.

Total supplies of wheat and flour were equivalent to about 7¼ million tons of wheat before the war and again in 1948, but home production accounted for over 26 per cent. in 1948 as compared with less than 23 per cent. pre-war. The sources of our imports have changed as the 40 per cent. provided by Canada before the war had risen to 78 per cent. by 1948. Sterling supplies, however, declined from a quarter to a fifth of our imports. The cost of our slightly reduced imports has trebled.

The decline in supplies of meat and poultry (excluding bacon and ham) resulted mainly from the decline of about one-third in home production in 1948 as compared with pre-war. Argentine supplies fell by a third, but as supplies from New Zealand rose by over 40 per cent., imports in 1948 were only 13 per cent. less than before the war. The cost of the reduced imports has nearly doubled.

The cost of imported bacon and ham, on the other hand, was less in 1948 than before

EGGS & PRESERVED
EGGS (Shell egg equivalent)
BUTTER, CHEESE & CANNED MILK
OILS & FATS
MEAT (Including Bacon)
WHEAT & FLOUR (Wheat equivalent)

THE CHANGE IN SOURCES OF U.K. FOOD IMPORTS

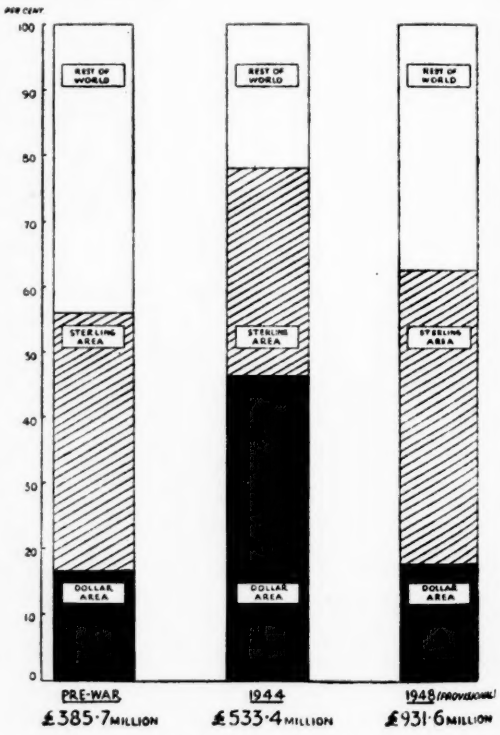
the war but this reflects only the serious drop in imports which were about one-third of the pre-war level, whereas import prices have risen to two-and-a-half times the pre-war level. There has been some increase in Canadian supplies, but we still lack the enormous quantities which came from Denmark before the war. Home production was little more than half the pre-war level.

Total supplies of oils and fats (excluding dairy products) amounted in both periods to about 1·1 million tons. The slightly increased imports cost nearly four times as much as before the war. British West Africa provided half the supplies in 1948 as compared with less than one-fifth before the war. Purchases from the dollar area were practically eliminated in 1948.

Although home production of sugar has risen by nearly 30 per cent. in the last 10 years or so, imports in 1948 were about a quarter of a million tons less than before the war. Moreover, there was a large increase in exports of sugar refined in this country making a valuable contribution to our foreign currency. As a result supplies retained in the United Kingdom fell below the pre-war level by some 15 per cent. Although retained imports of sugar fell by about a quarter the value has increased about threefold providing another clear example of the rise in the cost of imported food.

From these examples of some of the major though by no means the only changes which have taken place since pre-war it is clear that the whole pattern of our production and procurement of food has been largely altered. The most obvious effect of the war has been the increased output of British agriculture which for many years before the war was at best a stationary industry. In pre-war days only 31 per cent. of the calories consumed in this country were home produced. By 1943 the percentage had risen to 43 per cent. owing to the great increase in the output of wheat and other grains, potatoes and sugar beet. This, however, proved to be the peak year in agricultural production which has since fallen to 37 per cent. in 1948. The need to save dollars and other hard currency by growing our own food was responsible for the Agricultural Expansion Programme announced in 1947 with its emphasis on livestock production. A grassland improvement campaign was initiated aiming at the eventual contribution of the equivalent of an additional 1½ million tons of feedingstuffs a year.

As regards the changes in the sources of our imports, the general pattern for certain foodstuffs is illustrated in the diagram based on arrivals in thousand tons. Soon after the outbreak of war the German occupation of many European countries cut off valuable supplies of bacon and dairy produce and alternative sources of supply had to be found. Canada and the U.S.A. provided such an alternative source of supply and under lend-lease the U.S.A. sent us large quantities of bacon, dairy produce, dried egg, canned meat and fish and canned milk. By 1943 lend-lease supplies amounted to over 14 per cent. by value of our total food imports. The cessation of these supplies on the termination of lend-lease created a serious problem of supply and when in 1947 the American Loan began to run out and a balance of payments crisis occurred, drastic cuts had to be made in supplies from dollar sources and hard currency areas. We were forced to turn to the Sterling area and to Europe whose food production was gradually improving for more and more of our food imports. But for Marshall Aid and the Canadian credit we would have had to curtail even further our purchases from North America.



SOURCES OF U.K. IMPORTS OF FOOD
(Analysis of Value)

Changes in the terms of trade have meant a deterioration in our position as compared with the immediate pre-war years. To some extent this has been met by a shift to cheaper items of food, but recently the position has become complicated by the shortage of dollars which prevents us from buying in the cheapest market. Marshall Aid is helping appreciably the flow from hard to soft

currency areas but apart from this the two markets have become to all intents and purposes separate watertight compartments.

Turning to the world position as a whole, world exports of food have not declined greatly as compared with pre-war because the drastic reductions in the food exports from Far Eastern and European countries have been largely offset by the expansion of North American exports. According to F.A.O. which published an index number of the volume of international trade in food, world exports (excluding U.S.S.R.) in the year 1947/8 reached 90 per cent. of 1934/8.

The war has been responsible for great changes in the pre-war system of food procurement through private channels and the ordinary machinery of international trade. Governments themselves have become purchasers and sellers of all kinds of foodstuffs and the older traditional methods have been largely replaced by bulk buying and long-term contracts. Commodity markets in Great Britain have largely disappeared and producing countries for their part have attempted as in the case of tea to transfer the markets to their own country. British procurement policy after the war was based on import planning for which purpose elaborate programming was adopted and this has been carried out mainly through the Government's bulk purchases and long-term contracts, supplemented by private buying abroad under individual specific licence or open general licence. At the present time the Government is committed to 54 long-term contracts of which 12 relate to milk products and eggs, 12 to oils and fats, 8 to meat and bacon and 7 to sugar. Of the 54 contracts 24 are with British Colonies, 6 with Australia and 4 each with Canada and New Zealand.

National Expenditure on Food.

Before passing to consider the pattern of Britain's diet and examining the changes in consumption which have taken place since 1938 it may not be out of place to examine the broad features of the nation's expenditure on food. In 1938 food other than alcoholic beverages accounted for 30 per cent. of total personal expenditure but in 1948 this had fallen to 27 per cent. In the period, however, the amount spent on food rose from £1,297 m. to £2,181 m. Averaged over the whole population weekly household expenditure on food worked out at 9*s.* 8*d.* a head in 1938 and at about 15*s.* in 1948. The White Paper on National Income and Expenditure provides an estimate of 1948 consumption valued at 1938 prices and this shows that there was a rise of 63 per cent. in food prices between 1938 and 1948 though full allowance cannot be made for changes in variety, quality and associated services. Other prices, however, rose much more, the average for all consumers' goods and services being 80 per cent. though here again full allowance cannot be made for changes in quality.

The fall in the proportion of food expenditure to total personal expenditure is due in part to the fact that food has become heavily subsidized. For the year 1948 the net amount of subsidies on food, after deducting Customs and Excise Duties was £358 m. equivalent to about 2*s.* 9*d.* a head a week. Food accounted for some 39 per cent. of the total national resources devoted to the provision of consumer goods and services in 1948 as compared with only about 34 per cent. in 1938.

For the United Kingdom, consumption level figures based on the methods developed by the Special Committee of the Combined Food Board were first published in 1944 and the calculations were extended back to the pre-war period. Figures calculated on the same basis have been continued up to date and the nutrient factors differ slightly from those adopted later by F.A.O. in its Food Balance Sheets.

These United Kingdom figures are a measure of the supplies of food entering civilian consumption at the retail stage and through catering establishments, schools and other institutions. The method followed in compiling the averages is to add together, after making appropriate adjustments, the quantities of food imported and home produced and then to divide the result by the civilian population. The adjustments include allowances for stock changes, exports, produce consumed on farms or obtained from gardens, allotments and back-yard poultry, food used as seed or animal feed, industrial usage and military requirements.

The figures are all *national averages* and therefore when dealing with the data it must be borne in mind that they have all the advantages and all the disadvantages inherent in the average. They tell us nothing about what any particular individual has eaten nor do they provide information about the food consumption of the different economic and social groups in the community. They represent the national average over a population of some 50 million persons—men, women and children—including heavy manual workers whose daily calorie requirements may be well over 4,000 calories, sedentary workers requiring perhaps 2,500 calories and infants under a year old whose needs may be less than 1,000 calories. Likewise for the other nutrients, the figures are averages. A heavy worker would only require 0·8 grams of calcium per day whereas the infant would need 1 gram and a nursing mother 2 grams.

But though consumption level data do not show changes in the amount of food eaten by different individuals, social classes or age groups, they are the only available data for the country as a whole and are the only figures which enable us to compare the overall position in different periods. Owing to the methods used for measuring supplies, accurate figures cannot be calculated over periods of less than a year. Supplies do not always come to the market the same month each year, and sugar, for example, bought in July might be used for fruit preserving and not consumed till February of the following year.

Changes in consumption of the various food groups before, during and since the war are summarized in Tables I and II.

TABLE I.—Annual Consumption in lb. per head in U.K.

	Pre-war	1941	1944	1947	1948/49 (Provisional)
Dairy Produce (milk solids)	38·3	40·7	49·0	48·7	50·6
Meat (edible weight)	109·6	85·6	96·1	82·0	69·8
Fish (edible weight)	26·7	15·5	20·3	31·8	29·9
Eggs (fresh egg equivalent)	24·0	19·2	23·2	20·9	22·0
Oils and Fats (fat content)	45·3	39·9	39·0	33·9	40·9
Potatoes	176·0	188·2	274·6	284·1	266·3
Grain Products	210·1	257·2	252·8	240·2	252·8
Sugar and Syrups (sugar content)	109·9	70·9	75·7	85·0	91·2
Vegetables	107·5	109·1	124·8	114·0	115·6
Fruit and Tomatoes (fresh equiv.)	141·4	59·7	93·6	132·4	128·6
Tea	9·3	8·1	7·4	8·5	8·0

TABLE II.—Nutrient Equivalent of Supplies per head per day moving into Civilian Consumption (U.K.)

	Pre-war	1941	1944	1947	1948/9 (Provisional)
Proteins, animal gm.	42·7	35·7	41·4	43·0	40·7
„ vegetable gm.	37·2	46·7	45·7	47·7	47·5
„ total gm.	79·9	82·4	87·1	90·7	88·2
Fat (from all sources) gm.	130·2	113·4	124·0	105·4	110·4
Carbohydrates gm.	377·0	367·5	386·3	391·2	408·8
Calories	3,000	2,820	3,010	2,880	2,980

The main change which has taken place as compared with the pre-war pattern of food consumption is that to-day we are consuming *per capita* more milk, fish, potatoes, vegetables and grain products, but less meat, oils and fats, fruit, tea and sugar. The biggest decrease has been in meat and the restriction on its consumption has been severely felt. Though meat is not an essential constituent of human diet and indeed vegetarians get on very well without meat, it lends palatability to the diet and is an excellent source of proteins. Expressed in terms of nutrients, the main difference is that we are consuming about 28 per cent. more vegetable protein, rather less animal protein and about 15 per cent. less fat from all sources. The higher income groups have suffered a considerable reduction from their pre-war consumption level but the consumption of certain important foodstuffs by the lower income groups has risen appreciably. This is notably the case with liquid milk. Production of liquid milk has largely increased and average consumption is now about 5 pints a head a week compared with 3·2 pints pre-war. The National Milk Scheme has enabled much of the increased supply to be made available for mothers and children.

So far we have been concerned with the supply of food as a whole, but to give a complete picture of the food supply position in any country, consumption levels need to be supplemented by further studies of the actual consumption of food in the home by various groups of the population important for economic or social reasons or because of nutritional vulnerability. The family is the basic unit of the State and within the family the food is shared according to need and

tastes. Studies of individual diets are also necessary as they can take fully into account food eaten outside the home and can be related to special requirements such as the needs of heavy workers, children or expectant mothers.

We are on much more difficult ground when we come to examine these problems than when we are dealing with the objective statistical facts of consumption levels, food imports or agricultural production. We are now concerned with individual preferences, individual needs and family sharings and in such personal matters there is room for immense variations and even idiosyncrasies not altogether unlike those of Jack Spratt and his wife or the man who according to the old jingle always ate his peas with honey—

> 'I eats me peas with honey
> I've done it all me life,
> It makes the peas taste funny
> But it sticks 'em to the knife.'

Consumption level enquiries stop short at the total national supply of food available at the retail level. They do not show in any way how the food supply is distributed among families or individuals. The distribution of the available food within a country is of the greatest importance in considering the health and well-being of the community. A food supply which on average is just about sufficient to maintain health will, if inequitably distributed, leave pockets of the population with inadequate diets.

The earliest attempt to build up our information about family food consumption was through the collection of family budgets which in effect are a balance sheet of the income and expenses of the families concerned. As far back as 1787 David Davies, when Rector of Barkham, collected family budgets of agricultural labourers in his parish as did Sir Frederick Eden in the same century. The great pioneer of the method was Le Play whose classic work on the subject 'Les Ouvriers Européens' was published in 1855. Since then many studies of family income and expenditure have been undertaken of which the Ministry of Labour's family budgets are among the best known. Recent surveys of family food consumption, however, are much more detailed and provide material relating to nutrition which is not available, at any rate to the same extent, in the older system of family budgets. The largest enquiry of this type is the Food Survey of Working Class Households undertaken by the Minister of Food which was inaugurated in 1941, at first in co-operation with the Ministry of Health. Representative samples of urban working class households have been studied continuously at the rate of 600–700 households a month with but a few small gaps when special groups were substituted for the general sample. In addition some information has also been collected about other groups such as middle class households, rural families and old age pensioners.

Much valuable material on average daily consumption of, and expenditure on, each food has been collected by this survey which had its origin in the war-time need to keep a watch on food consumption in the home so that any signs of under-nutrition might at once come to notice. In Tables III and IV, both of which relate to working class households, a brief summary is given of the main results.

From Table III it will be observed that there has been a fairly steady increase in milk consumption with a peak in 1945 which has since been exceeded. Sugar shows a steady rise since 1942. Cheese on the other hand shows a fairly steady decline in working

TABLE III.—Consumption of Certain Foods in the Home. Urban Working Class Households (in ounces per head per week except where otherwise stated)

Food	1942	1943	1944	1945	1946	1947*	1948†
Bread and Flour	67·0	66·6	67·0	68·0	66·0	67·9	74·7
Meat and Meat Products	26·3	26·2	28·3	26·4	26·6	25·5	27·3
Butter and Margarine	6·1	6·2	6·3	6·4	6·3	6·3	7·0
Milk (liquid) pints	3·5	3·6	3·7	3·8	3·8	3·8	4·1
Cheese	3·6	3·1	2·6	2·5	2·5	2·3	1·9
Sugar	8·4	8·7	9·1	9·1	9·6	10·2	10·5
Eggs (inc. dried) equiv. eggs	1·4	2·2	2·9	3·0	2·5	2·3	2·2
Potatoes (inc. chips)	68·5	71·2	71·3	68·5	73·8	70·8	66·0
Other Vegetables	31·4	34·5	37·3	36·3	34·6	30·8	32·8
Fruit	12·3	12·8	14·0	15·9	15·9	21·7	22·7
Fish	6·6	6·5	7·6	9·2	10·6	9·5	10·1

* Average for January–September.

† Average for year excluding February and March.

class consumption from 3·6 oz. in 1942 to 1·9 oz. in 1948. Potatoes reached their maximum in 1946 when bread rationing reduced somewhat the consumption of cereals. Comparing working class consumption in 1948 with 1947 it will be noted that there was a general improvement for all the commodity groups quoted except cheese and eggs. Reduction in the latter was due to the practical disappearance of dried eggs which are a dollar import. The reduction in potato consumption was due to better supplies of preferred commodities. Food expenditure (Table IV) has risen steadily until in 1948 it was practically 50 per cent. over that of 1937/8 though I should explain that the basis of the figure for the pre-war year is not exactly comparable with the food survey figures.

Several precautions have to be taken in utilizing the information provided by the survey. In the first place the survey is concerned with the household as a unit and does not give information about what the individual members may eat. Further, it does not include food eaten outside the home in canteens, schools or restaurants. For these reasons and because the food is measured at a later stage in the distributive process than in the consumption level method, the calorie figures given by the two methods are not comparable.

TABLE IV.—Food Expenditure in the Home. Urban Working Class Households (per head per week in pence)

Food	1937/8	1942	1943	1944	1945	1946	1947*	1948†
Cereals		20·4	20·8	22·0	23·6	23·8	26·4	30·7
Meat and Meat Products		27·3	27·4	30·8	28·7	28·5	31·9	29·1
Fats		5·9	6·2	6·2	5·9	6·0	5·7	6·4
Milk		14·2	15·3	16·0	16·3	15·9	14·7	16·6
Sugar and Preserves		4·1	5·0	5·7	5·4	5·8	5·8	7·7
Potatoes		6·1	6·1	6·0	6·5	7·1	7·6	9·3
Other Vegetables and Fruit		15·6	15·5	16·9	17·4	19·0	25·0	27·1
Fish		6·4	6·4	7·7	10·1	11·3	11·0	12·1
Other Foods		14·3	14·8	15·8	17·7	17·3	15·6	18·1
TOTAL	105‡	114·3	117·5	127·1	131·6	134·7	143·7	157·1

* Average for January–September. † Average for year excluding February and March.
‡ Average expenditure per head on food consumed in the home. Ministry of Labour Budgets 1937/8.

To supplement the information obtained from family food surveys it is necessary to undertake research into individual diets. The technique is difficult and may be tedious to the persons co-operating because it involves measuring every morsel of food eaten during the period of the investigation. Few individual surveys of any size have as yet been carried out, though very recently through the co-operation of a large engineering firm in Newcastle a pioneer survey was made of the family and individual diets of a group of this firm's workers.

THE FUTURE OF OUR NEW FORESTS[1]

BY

PROF. H. G. CHAMPION, C.I.E.

I. OUR FORESTS OF TO-DAY

THE intention of this address is to invite your attention to some of the problems that must be expected to arise in the time of ourselves, our children and our grandchildren in connection with the new forests which have been planted up since the First World War and which are being planted up under the post Second World War policy[2] approved by Parliament in 1945.

To get the picture clear, I must remind you in barest outline of the background forest history of our country, particularly of the areas which are being afforested. Britain was originally a very well wooded country, being covered with mixed deciduous forest except on the exposed tops and upper slopes of the higher hills. In the course of centuries, the processes of denudation, already locally extensive in Bronze Age times and greatly speeded up by industrialisation and the big increase in population that went with it, have reduced the forest cover to some 5 per cent. of the total surface—counties range from 2½ per cent. (e.g. Leicester) to 14 per cent. (Sussex). We are left with residual woodlands whose relation to the original natural forest is still traceable and which with the exception of a few of the old Crown forests are now mostly in private hands, and with plantations, sometimes of the original species like the Chiltern beech woods, but mostly of introduced species, generally conifers including Scots pine outside its natural home in Scotland. This last development reflected the dwindling demand for hardwoods, notably for shipbuilding, and the greatly increased demand for softwoods. Real interest only began to be taken in State afforestation at the beginning of this century and led to the investigation and report of the Acland Committee (1917), which in turn led to the setting up in 1919 of the Forestry Commission with a programme which, despite difficulties, planted up 138,000 acres in the first decade and 230,000 more in the second. The total in 1948 was well over half a million acres. During the Second World War, plantation work was naturally greatly cut down and fellings took place in the older woods. The need for an expanded post-war programme to repair the damage done and so reduce our enforced reliance on timber imports, was at once realised and proposals for an appropriate Post-war Policy were made in an able report presented by the Forestry Commission to Parliament in 1943.

[1] Chairman's Address to the Forestry Sub-Section, Newcastle Meeting, 1949.

[2] Cmd. 6447, 1943.

II. THE POST-WAR PLAN

This report which was accepted in all its main features is in process of implementation. The stress is mainly on an extended programme of afforestation by the State, i.e. the creation of new forests, and the improvement of the management of privately owned forests leading to increased production. It is with the former that I am primarily concerned.

The programme aims not only at replanting 600,000 acres, mainly rehabilitation of wartime felling areas, but also at afforesting half a million more acres in the first decade. The target for 50 years is 3 million new acres to make a grand total of 5 million acres of effectively managed woodlands. It is estimated that this area would then carry enough timber to carry us over an emergency, involving the cutting off of imports, for several years, and its current production would meet about one-third of our current consumption instead of the present one-twentieth.

We have first of all to review the prospects of successfully carrying out this programme. I am prepared to say at once that it is quite feasible and that in my opinion it is likely that in its essential features, it will be done. The times will not stand still; our needs, our views, our methods will all surely change considerably over half a century, but several of the reasons for this view are likely to be valid for far longer. It is worth mentioning some of these reasons.

Firstly, wood is being increasingly recognised as an essential material for human welfare: substitutes are always being brought forward, above all in times of wood scarcity, but wood is always finding new uses, more than compensating any losses through substitutes. We shall always want wood and lots of it.

Secondly, we have considerable tracts of land which are only suited to tree growth, and

much more, especially on the less fertile soils, which would be more productive under forest than under any other form of land use. Our climate is favourable to tree growth : it is also favourable for grass growth and a balance has to be struck between forest and pasturage, but there is room for both, and we need both.

Thirdly, we are an industrial country and need the widest range of raw materials we can get. Wood is of ever-increasing importance as a raw material, and although at present our wood industries are poorly developed, this is mainly ascribable to the lack of steady and adequate supplies of wood, and the more favourable position of countries which still have extensive forests.

Finally, reference to the history of the continental countries which recognised much earlier than ourselves the importance of an adequate productive forest area to a well-balanced economy, encourages the view that once a country has realised this and set itself seriously to the task, there may be temporary setbacks, but there will be no reversal of policy.

III. The Problems Involved

Some of the problems to be faced will be new, but for the most part they will be concerned with carrying out operations and finding markets for produce, both on a much bigger scale than hitherto. These problems may conveniently be grouped as dealing with : (i) risks to be insured, (ii) forest management, (iii) man-power and mechanisation, and (iv) marketing and utilisation.

(i) *The Risks*

From earliest youth, forests are exposed to a variety of risks from the elements, from disease, and from man's own actions. It is recognised that the plantation or artificial forest is much more exposed to such risks than is the natural forest, the constituent species of which have through generations of exposure been purged of most elements which cannot survive under the prevailing conditions. This must not, however, be taken to imply that any given natural forest is immune when these risks materialise, for it is being increasingly recognised that cyclic changes may well be the normal history and some phases may take place so rapidly as to appear catastrophic, though the original form may ultimately be re-established. We also have to recognise the risk to an indigenous tree of the introduction of pests which may prove lethal as in the case of the chestnut in America.

To consider first the *danger from fire*, it must be noted that for several reasons the risks will steadily increase for some decades while we are building up our forests. The risks are always much higher in young than in old woods, whether coniferous or broad-leaved. We shall also be getting increasingly large blocks of young woods, and more large blocks. Moreover, we must bear in mind that maximum risk and damage recur at irregular and often rather long intervals, when unusual coincidences of unfavourable factors such as an exceptionally dry period, strong wind from a dangerous quarter, and a time of high incidence of acts likely to start fires—say a Bank Holiday—and we may not yet have experienced the worst.

Several countries have far more experience than we have in preventing fires and in combating them, and are continually carrying out further research, e.g. Canada, U.S.A., Germany, and France. It can fairly be said that this experience has been largely drawn upon in Britain, but whilst remembering that we have to acquire our own experience under our peculiar conditions, and even to buy some of it rather expensively, it might be said that we have not done as much as we might, particularly in developing techniques to establish fire-resistant belts dividing up areas of high risk.

Britain is a windy country and our new forests are by the nature of things commonly situated on the most exposed sites. In this respect we probably have a risk of *wind damage* greater than any other country where forestry has been developed. We must also remember as a partial explanation of why we have no tradition of widespread destruction of woods by storm, that our chief native dominant hardwood and conifer, e.g. oak and Scots pine are among the most wind-resistant trees. We cannot overlook the facts that wind-throw has been so frequent and extensive, above all with spruce which we are using on a big scale, as to have caused serious losses and to have fundamentally affected silvicultural and management techniques. We have also to bear in mind the fact that the risks increase very greatly as the trees get older and taller, particularly when fellings are in progress, and most of our plantations are at present in a phase of relatively low risk. There is room for doubts as to how far our current planting methods which use relatively high ridges and furrows tending to cause development of unidirectional root systems, may increase susceptibility to wind-throw later on and we often have to deal with sites with shallow soils or high water table which inhibit deep rooting.

It is an accepted proposition in biology that artificial conditions, culminating with the monoculture or pure crop involve increased *risks of ill health* or death to plants and animals. This does not mean that more or

less pure associations do not occur in nature and remain healthy over long periods of time, even several generations : for they do occur, particularly in regions where conditions are limiting for plant or tree growth and the flora is consequently poor in species. However, even here, it is quite possible that a small admixture of other tree species or the ground flora may be as important as the presence of the so-called trace elements in the soil. Furthermore, as already noted, the risks involved are usually greater with exotic species than with indigenous species, for the reason that the latter have evolved in equilibrium with all the factors, physical and biotic, of the habitat, whereas the former are unlikely to be equally well adapted to them. This difference may go unnoticed, and indeed have no deleterious results, in youth, or under more or less normal weather conditions, but develop in later life or when exceptional conditions occur, especially on the less well-chosen sites : there have been all too many instances of a promising start followed by sad falling off later as is being reported locally with Sitka spruce. Then there is a further risk that in the course of time, one of the natural enemies of the exotic may be introduced by chance, without its associated natural controls—once again, a risk that has frequently materialised with disastrous consequences before the obvious remedial steps could be discovered and taken. In 1948, one-quarter of the conifers planted were Scots pine, and all the rest were exotics.

Probably the majority of failures ascribed to fungi, insects and even physical agencies such as drought and frost, are in the ultimate analysis due to *faulty choice of species* for the given site, and to faulty choice of strain within the species. European larch provides the outstanding example of this experience at the moment, but we must expect further losses from this cause, though it would be a mistake to overrate their importance.

One more risk of this kind must be mentioned in view of the clear indications of studies made so far. We are concerned not only with the vegetative health of our trees, but also with the *soundness of the timber* they produce : heart rot may spread in the non-living heartwood of a tree without significantly affecting its further growth and vegetative health. On many sites in this country heart rot sets in with most exotic conifers far sooner than with the native Scots pine, and indeed, before good saw-log size is reached. Thus, in a Douglas fir plantation 51 years old, despite healthy appearance and an average height of 104 ft. 70 per cent. of the butts showed actual or incipient heart rot. Western red cedar has been reported to show similar tendencies. I am rather concerned over the damage to shallow roots by the use of track tractors.

Finally, there are risks involved through the unknown effects of our artificial crops on the *fertility of the soil* itself. In England we have had no indigenous coniferous crops since the Ice Age. It is an established fact that many coniferous crops render soils more acid than they would be under broad-leaved trees, and the indications are that this process may go on to a stage where the acidity is too great for regeneration and even for healthy growth of the conifers themselves. Large areas of deciduous forest, especially oak, in the plains and lower hill slopes, on the Continent as in Britain, have gone over to heathland after denudation, and have been or are being reafforested to pines and other conifers, both for economic reasons and because it has proved next to impossible to raise broad-leaved trees. It must be noted that one of the most widespread tendencies of to-day is the attempt to introduce broad-leaved species into these coniferous plantations, and to do so at as early a stage as possible in new afforestation work.

Finally, it remains to mention the possibility of *difficulty in acquiring land* for afforestation. This raises questions of politics and national economics that I must leave for the symposium, but I believe that the necessary land will be found from our 11,000,000 acres of rough pastures, its withdrawal from pasturage being compensated by improved use of the balance.

(ii) *Management problems*

We have seen that the main objective of our forest policy is to build up and hold an adequate stock of timber with due regard to maintenance of amenities and certain other secondary considerations. It will be remembered that the possible alternative of building up a stock of imported timber was rejected.

Continued health and good growth—and the two are inseparable—necessitate an appropriate series of thinning and regeneration operations, the general lines of which are well established, so that the problems are mainly a matter of scale and detail not calling for further discussion here. There is one issue, however, that has hitherto been badly neglected. It is that of *quality versus quantity*, and it concerns comparative studies both between and within species. We have been far too prone to assess the success of a plantation by its early height growth—the faster, the better. There is one respect in which this view is acceptable, for there is little doubt that a plantation which makes a good vigorous start, and particularly one which quickly closes canopy, is much the most likely to continue to grow well. But rapid growth means

wide growth rings, light wood, and very usually coarse growth, large knots, and timber of uneven and often poor quality, particularly if the rapid growth is used as justification for wide spacing in youth without pruning operations.

This problem is easy to state, less so to answer. We are often, if not usually, limited as to the species to plant, by the nature of the soil and site. The establishment of the slower but better timber species is generally more difficult and more expensive, and often more risky than that of the coarse quick grower. It must, of course, always be kept in mind, what we are growing the timber for. In fact, *is* quality as important as quantity? Are we not growing against a possible emergency need involving mainly short term uses where serviceability is all that is wanted, indicating as the objective maximum quantity of supplies of a quality just good enough for the purpose in mind? What cannot we manage with, if we are pushed? But this argument would ignore the implications of the second part of our primary objective. We have not only to raise, but also to hold an adequate reserve. Holding a stock of growing timber unavoidably involves the production of a large volume annually from thinnings, and ultimately mature timber which will go towards meeting current requirements both for timber as such, and as raw material for industry. Here, quality becomes much more important particularly if the home-grown material has to compete on even or—as now—on unfavourable terms with imported material. After the war, we found ourselves with an excess of low quality timber in a time of timber scarcity.

The problem of discovering the best *regeneration methods* is not one of the most urgent at present, though it will significantly affect management, as will our growing knowledge and experience of the risks to which our forests are exposed. Our forests may have to be replaced sooner than we are contemplating if early falling off of increment or onset of unsoundness on the sites available for forestry is at all prevalent. On the other hand, we are likely to hold on to healthy crops as long as their current increment is satisfactory disregarding a fall in percentage growth in view of the dominant objective of holding stock. Judging from continental precedents, e.g. in Denmark and Holland, the indications seem to be that though natural regeneration may not be impossible we shall continue to rely mainly on artificial regeneration, for the most part by planting: when pressure on the land is great, the uncertainties and delays commonly involved in natural regeneration are not readily accepted. As elsewhere, however, we may well regenerate Scots pine by natural seeding and some mixed hardwoods similarly. I do not believe we shall ever adopt the selection system on any scale for our softwoods though the second and later generations may well be less regular than the first.

We come next to the question of applying a *form of management* suitably designed to give the maximum sustained yield whilst continuing to hold the necessary growing stock from which to meet our requirements in an emergency. Our immediate tasks are to create our forests and to build up the desired stock as quickly as possible: if no other factors were involved, we would have liked to complete our 2 million acres of new afforestation in a year or two, or say a decade—but very many other factors are in fact involved preventing us from doing this. Our primary effort clearly must be to get every acre of forest to produce annually the greatest amount of wood, with due regard to species and quality requirements, of which it is capable.

The teaching of 'orthodox' forest management is that for sustained yield all *age classes* must be proportionately represented. In big afforestation projects like ours, this cannot be attained all at once, but management should be so planned as gradually to achieve this structure, it may be in two or three generations. A first step might be a heavier thinning regime in our earlier plantations to hasten the attainment of maturity in size and reproductive capacity. In the course of time we shall develop industries based on the produce of the forests, and those industries must have steady supplies. If there is too little produce, they may lose money or fail and there will be resultant unemployment and serious disturbance of the local social and economic structure; if there is too much produce, they may be unable to absorb it. In any case, it has to be recognised that many of our forests will have been established in the decade or two after acquisition and will contain crops of only one or two age classes out of the whole rotation range. So this question of sustained yield will have to be faced though the problem does not become important in well-managed crops much before half rotation age, say 30 to 40 years for our softwoods. We shall have to pay more attention to the spatial relations of the age classes than we have in our initial planting work, in view of risks of wind damage. We may quite well adopt an alternation of species for the maintenance of soil fertility.

A few words must be added on the *amenity question*. The public is increasingly insistent on the need of open land, as opposed to closed forest, for the maintenance of physical and mental health. The approved policy takes

cognizance of this and includes proposals for constituting national forest parks in or including afforested areas. Will these proposals when put into effect, satisfy this demand from our people, or are there further problems? That there are such is indicated by the continual storm of criticism of afforestation activities appearing in the public press. The charge appears to be, not that these activities never add to the amenities, but that many of them in the opinion of the critics, detract from existing amenities. Feelings are strong and real, but the speaker has little doubt that they are usually the unthinking reactions of the moment, giving little or no heed to the questions of the morrow: we all know the comparable strength of feeling opposed to the cutting of a wood or even a tree that people are accustomed to see in a familiar setting. This granted, we are left with problems of attaining the national objective with a minimum of avoidable opposition from all sections of the public, however generated, and there is certainly room for closer study and discussion of ways and means, and still more, for advance in applying the resultant suggestions.

(iii) *Man-power and Mechanisation Problems*

Up till the Second World War, foresters were at pains to demonstrate that their form of land use, apart from its many other merits, gave very considerable employment; if not as much as arable farming, then at least many times more than the pastoral use. It is a reflection of the times that now they are far more concerned with finding means of economising labour. Is this a phase, or is it a matter of continued importance? It is obviously a question of social economics, the long term answer to which is clearly that efficient mechanisation enabling our man-power to accomplish more for a given effort—this includes of course the building of the machine, the collection and processing of the materials of which it is made, etc.—is a good thing. The short term answer is much more difficult, and will not be attempted here. Suffice it to note that much effort is being devoted in this country and others to develop machines for forestry and timber operations and to study the economics of their use.

An important aspect of the labour problem is that of the effect of improved communications. It is another trend of the time, that forest country is being opened up with roadways which enable road transport, with its great flexibility compared with railways, to cut down wherever possible the man and animal power that has hitherto effected so large a part of timber extraction work. Felling and bucking are similarly becoming more and more successfully mechanised. Owing to varying terrain and varying size and form of trees, forestry will never go as far along this path as agriculture: the methods in fact seem to be available and it is application that lags, sometimes for good reasons. Meanwhile, appropriate measures of housing, etc., are of vital importance to attract and retain labour.

(iv) *Marketing and Utilisation Problems*

As we have already noted, the building up of a large stock of growing timber in healthy condition involves the removal of large quantities of thinnings, i.e. small-sized material, typically of limited usefulness and low priced. The private woodlands of the country have in the past as a whole produced less and poorer timber than they might have because these thinnings have been so largely neglected. The reason, when one is given, is usually and often correctly, that the sale price would not cover costs. With the big national programme of afforestation and tending, there will be vastly more of these thinnings for disposal, in fact, the annual volume may work up to some 40 million cubic feet. Will not the former difficulty be accentuated? There are, however, two factors which make the position more favourable rather than less so. Firstly, there is the fact that the availability of large ensured supplies justifies the investment of capital in enterprises based on this material. Secondly, there are improved prospects of much better organisation for collection, sale and use. The exotic pine plantations of New Zealand provide the now classic example of phenomenal success with the actual afforestation coupled with complete breakdown of the thinning and utilisation side: a warning to others. However, the advanced industrialisation of this country ensures good prospects of establishing or expanding any new industry which is based on an assured supply of raw material and gives a product for which a demand exists or can be developed.

Obviously the product must be within the economic reach of the potential consumer and must not be undercut by cheaper imported alternatives, and here one again gets to a set of serious problems that are outside the scope of this paper. In Britain, there are considerable local markets for very many kinds of small produce owing to our dense and well-distributed population, but these markets are quickly saturated near any big block of forest, and then it becomes a question of building up industry at centres carefully chosen, taking into account that supplies must be adequate (often relatively large) and certain, and that such lower grade material cannot carry high transport costs. It is felt that there is no justification for pessimism in

this direction, though patience is needed and probably some initial losses must be borne.

Our biggest demand for thinning products is for *pit-props*. Though there is no foretelling developments in mining methods, we must always be prepared to meet this demand, but if it should fall off significantly, the problem of profitable utilisation of thinnings would become much greater. It should be noted that in 1948 we imported about 55 million cubic feet of pitwood against a home production of 18 million. The direction in which such a loss might be compensated is to be seen in the steadily increasing use of wood-pulp as the basis of an ever-expanding chemical industry, but even here we need to remember that wood will always be in competition with other plant materials, notably the waste (and therefore cheap) products of agriculture.

IV. Indications for Current Action

This review of the problems and probable situation in future years as I see them, leads me to the main purpose of this address, which is to direct attention to possible lines of action for improving the prospects that our new forests will fulfil—and if possible more than fulfil—what we hope of them.

First and foremost, a better knowledge is needed of the relation between our forest trees and the soils and sites on which we set them out. There have been too many complete failures, notably with European larch, and they indicate beyond all question that a far greater area exists in which performance is below potentialities, if indeed an appreciable part of it may not fail before reaching maturity or even exploitability. Knowledge of the long term effect of tree crops and their treatment on the soil is equally deficient. Disregarding the slow start, even now the force focused on these vital matters is inadequate in relation to the very big issues involved. It calls for a joint effort between the forest experimentalist and the specialist research worker in his laboratory using the latest scientific equipment and techniques : there have been useful beginnings in the last three or four years, but more is needed.

Secondly, we have to profit more from the lessons that agricultural and horticultural research and practice can teach us. Our new forests depend for their rate of growth, their disease resistance and the quality of their produce in yet distant decades, on the quality of the stock we plant out now, and no short-comings can be remedied for a tree generation. It is still incredible how little effort has been put into isolating the best existing stocks (genotypes) of the species in general use and developing improved types in view of the established facts. We have been content to let Sweden and little countries like Denmark and Holland do our work for us and to think about following them a decade or so behind. If we cannot at the moment produce the necessary trained manpower, we could certainly get some of it from abroad, on short term arrangements if necessary, while we are training new men.

Thirdly, more attention is needed to assess dangers from fire, insects and disease, and to take appropriate steps to reduce the risks wherever possible and to increase our preparedness to meet outbreaks. As already noted, the stage is well set for epidemics, and yet again our contributions to general knowledge in these matters and our expert research and potential preventive forces are absurdly inadequate.

The development of timber industries might fairly be left in the first place to those countries where there are larger natural resources and where timber plays a more important relative part in national economy, but we should be quicker to adopt those developments, and to foresee our own particular needs and opportunities. Wartime conditions are not ideal for the development of a rational economy suitable for times of freer competition and tighter finance.

Finally, more attention should be given to finding directions in which the amenity value of forests can be enhanced without disproportionate loss of production or increase in costs : application follows too slowly on acceptance of a suggestion as a useful one and there is much scope for further exploration. The demand for broad-leaved trees in place of conifers can only be met to a quite limited extent, but 20 per cent. of the 1948 planting in England was of hardwood. In Scotland and Wales, however, less than 1 per cent. was broad-leaved species.

Conclusions

There is every reason to expect that our recently adopted plans can be carried to a successful conclusion, and indeed that they will be extended and improved before the 50 years which they cover is passed. We must expect some setbacks due to lack of knowledge and experience at the time the plantations were made, and setbacks due to damage from the elements and from outbreaks of disease and pests to which these forests are particularly exposed. But there are many circumstances in our favour to warrant optimism as to the ultimate outcome provided we make a much more determined effort than we have so far to profit from the lessons of past mistakes and of present knowledge, both in forestry itself and in the related branches of technology and science.

EARLY INDUSTRIAL SETTLEMENT IN NORTH-EAST ENGLAND [1]

BY

ARTHUR E. SMAILES

INDUSTRY as a factor of regional differentiation in North-East England is of long standing. The precursors of those far-reaching changes in the productive techniques and organisation of industry, which were to transform the face of the country and regroup population, appeared early in the North-East where we find some of the most old-established of industrial settlements. Yet in giving due recognition to the early appearance and importance of industry in the regional geography we must not assume that the areas affected were co-extensive with the industrial region of to-day. For centuries North-East England has consisted of an industrial nucleus surrounded by an extensive zone of rural country which in turn passes outwards into the well-nigh deserted highlands which almost completely frame and isolate the province. But the relationships in area between these essential constituents have changed in the course of time, and it is with this subject—the extent of the areas rendered distinctive by the early presence of industry and its concomitant settlement, and the nature of the development in these areas—that this paper is concerned.

We shall confine ourselves to the period before the beginning of the nineteenth century, just before the tide of industrialisation and urbanisation, gathering impetus from an even more portentous series of technical developments in manufacturing and transport, surged forward to engulf almost the whole extent of the coalfield as well as other tracts beyond its limits (1).

Coal-mining has a continuous history on Tyneside right back to the thirteenth century, and there are numerous references throughout the later Middle Ages to the working of coal in many localities elsewhere in Northumberland and Durham (2), as well as to the mining of silver-lead ores in the dales. But it is very doubtful whether before Elizabethan times these activities contributed much to the geographical differentiation of the localities concerned or employed any significant proportion of their population. Shipments of coal from the Tyne rose to considerable amounts during the fourteenth century, but there was little further increase for a long time after that (3). Coal was very little used as a domestic fuel except in the immediate vicinity of its outcrops, and its other markets were practically confined to some use for lime-burning and by smiths. Throughout the Middle Ages coal-working was merely an adjunct to the predominantly agricultural pursuits of the population, except in the immediate neighbourhood of Newcastle, which provided the seaborne coal. Likewise the sporadic ironworking and 'bloomery' smelting industries and the small saltpans scattered along the coast. Even at Newcastle it was the wool-trade rather than the coal-trade that made the fortunes of mediaeval merchants such as Roger Thornton. But the position changed during the reign of Elizabeth. Recent research in economic history has demonstrated the importance, before what is conventionally known as the Industrial Revolution, of an earlier period of rapid industrial development (4). This earlier quickening of the tempo of technological change was nowhere more significant than in our region, for it depended upon the extended use of coal and marked the change from a woodburning to a coalburning economy.

It is well known that the depletion of the country's timber resources threatened a fuel famine by the middle of the sixteenth century, which at last overcame the deep-seated prejudice against use of coal for domestic heating, especially in London where the scarcity of wood-fuel became extremely acute. The seriousness of the fuel problem also stimulated inventions in industry, e.g. in glass-making, which greatly extended the use of coal. The increased demand for coal as domestic fuel and its extended industrial uses both affected Tyneside especially. Land transport of so bulky a commodity was impracticable except for very short distances, and the easily worked outcrop coal on the banks of the navigable Tyne provided the nearest source of supply to London by water. So great was the resulting growth of the Tyne coal-trade that shipments increased fivefold during the second half of the sixteenth century.

[1] Paper read to the Geography Section, at Newcastle on Sept. 1, 1949.

Other industries were directly stimulated by the expanding coal-trade. In this connection the availability of cheap coal and of cheap water-transport were of paramount importance. It was not only that on Tyneside easily accessible coal and navigable water were present together ; the existence of a flourishing coal export trade added to these advantages. Small coal that was unsuitable for shipment to London was available for local industry at an almost nominal price, and bulky raw materials could be the more cheaply brought to the Tyne since they served as ballast for returning colliers. These were powerful attractions for such industries as the making of salt, glass, pottery, and copperas. First of these to become important was brine evaporation, an industry which in our British climate consumed great quantities of coal, although not necessarily coal of good quality. The large demand for ships and their accessories which was created by the coal-trade provided yet another stimulus for local industry, and we find shipbuilding expanding in step with coal-shipments.

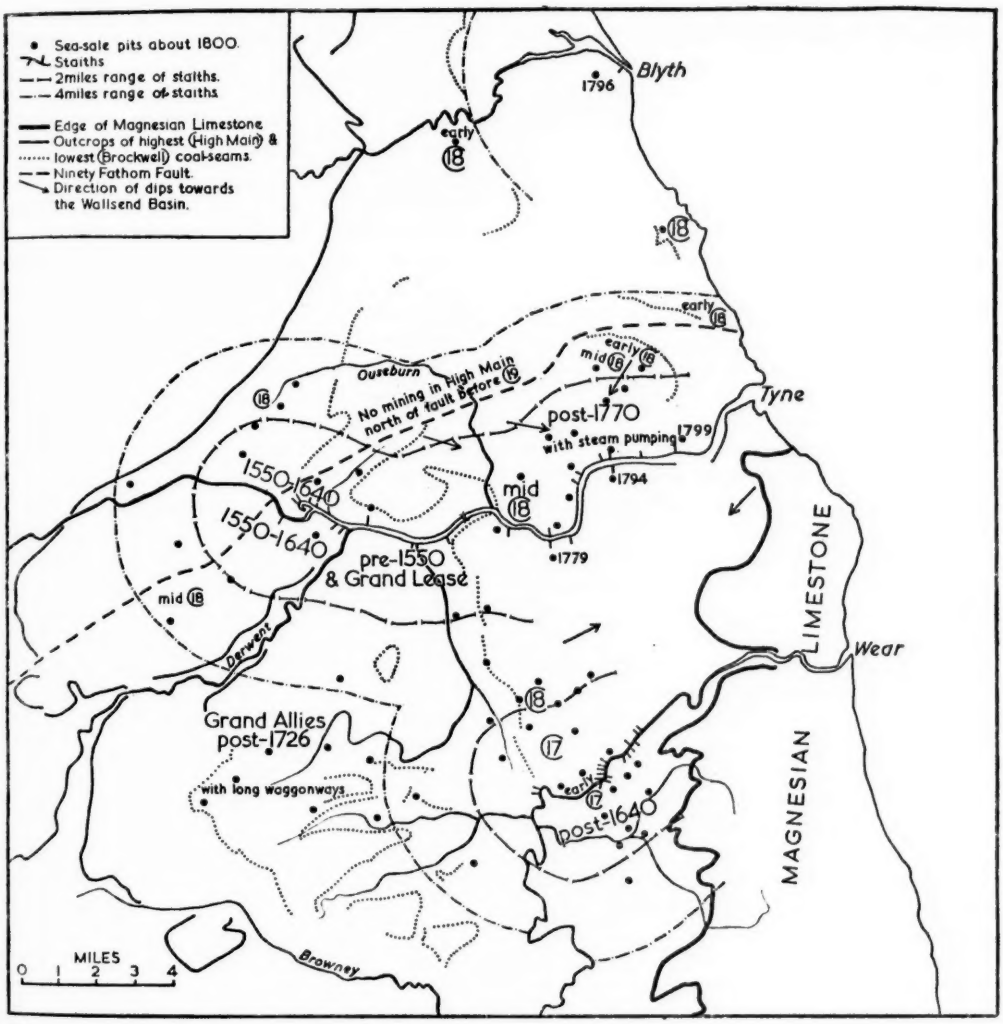
This intimate connection between the coal-trade and industrial development explains the essential features of the early industrial settlement in North-East England, the effective beginnings of which date from the middle of the sixteenth century. Specialised and distinctively industrial settlements first appeared at that time. The industrial workers were concentrated in groups to a degree previously quite unknown, for the industrial expansion involved a striking increase in the scale of organisation. The growing demand for coal required and called forth technical improvements to allow the pursuit of mining at greater depths, and market conditions were so advantageous that capital was sunk lavishly in applying the new inventions. With deeper mining came an increase in the size of pits. Similarly in other industries the application of new methods connected with the use of coal meant an increase in the size of their units, both because of the capital expenditure required and the high degree of localisation involved. In yet another way, however, the coal-trade contributed to concentrate population on the Tyne. Besides the workers employed in the actual winning of the coal and its transport to the shipping points or staiths, there was a numerous body of lightermen or keelmen engaged in the transport of coal on the river. The presence of the low Tyne bridge and the difficult state of the waterway made it impossible for seagoing vessels to negotiate the Tyne estuary and make their way right up to the staiths. All loading had therefore to be done by the keels which plied to and fro between the staiths and the ships, so that a large proportion of the aggregate employment in the coal-trade was actually engaged on the river. The keelmen, employed by the Hostmen of Newcastle, the merchants who monopolised the coal-trade, were a distinctive social group with their own dress and customs, and lived in colonies on the river-banks. Chief of these was Sandgate, an eastern annexe to Newcastle just outside the city wall, but there were other smaller colonies, for example at Dunston and Swalwell. The keelmen seem to have been recruited from the Border dales, both on the English and Scottish sides, and an early seventeenth-century document put their numbers at above 1,800 (5). Not all of them brought their families to settle permanently on Tyneside. Winter was an off-season in the coal-trade and many of the men who came to Tyneside for the summer returned in winter to their families in the Border dales.

The appearance of clusters of industrial workers, however, affected only a very restricted area. Naturally the keelmen's settlements clung to the river-banks, and the mining groups did not extend much further afield. The jealously organised power of Newcastle in the coal-trade, together with less favourable conditions for shipment, prevented any comparable trade from the Wear or from the Northumberland coast before the middle of the seventeenth century. On the Tyne it is true the increase in production in Elizabethan times involved some extension of the mining area. Previously practically all the sea-coal had come from the pits in the manors of Gateshead and Whickham, i.e. from the south side of the river between the mouth of the Derwent and the Tyne bridge. Besides considerable intensification of activity there, new pits were opened farther west on the south side of the river above the Derwent confluence ; and at the beginning of the seventeenth century similar development took place on the north bank west of Newcastle at Newburn, Denton, Elswick, and Benwell. But the limits within which spread of mining was possible remained extremely narrow. Technical advances, especially in drainage and ventilation, were allowing mining to be carried to greater depths, but the deep coal of the buried coalfield east of the Tyne bridge still lay beyond the physical limit of production and mining was confined to the outcrop field on Upper Tyneside. Here the heavy cost of transporting coal to the staiths severely limited the area that could produce for shipment. The least extension away from the river added significantly to the cost, and a distance of more than about 2 miles was still considered prohibitive. Other industries with their colonies of workers depended as we have seen upon the facilities

offered by waterside sites in contact with the coal-trade. The salt industry, earliest to attain prominence, of course needed sea-water in addition, and consequently a location either on the coast or right at an estuary mouth. Its chief centre was South Shields, though it also developed on the coast farther north at Cullercoats, Hartley and Blyth, and at Wearmouth. Indeed the requirements of these outlying centres of saltmaking gave the first effective stimulus to coalmining outside the Tyne district, especially on the banks of the navigable section of the Wear that lies west of the Magnesian Limestone.

That the industrial communities were essentially riparian is illustrated by Hollar's map of the Tyne in 1655 (6), which shows their linear plans along the riverbanks. Except for Newcastle itself they consisted at most of two rows of buildings lining the foreshore at intervals in front of the steeply sloping sides of the pre-glacial valley within which the Tyne flows.

During the course of the seventeenth century growth of the coal-trade and of other industries on the Tyne was not accompanied by a corresponding important extension of the mining area. As production was intensified in the established mining districts, the mining settlements grew in size and some new ones appeared between the older sites ; but Upper Tyneside remained the great centre of mining throughout the century. Although the use of railroads with large horse-drawn waggons became general after 1640, cost of way-leaves made it slow to extend the range within which it was profitable to engage in mining. The outstanding new development was the rise of Sunderland as a coal-port and industrial centre, and the expansion of mining on the Wear in its hinterland. In 1600 the Newcastle Hostmen had been more strongly



Early Mining in North-East England

entrenched than ever as lords of the coal, thanks to the charter which legalised their pretensions to monopoly. So far as the Tyne was concerned their dominance was long maintained, but they were less able to deal summarily with competition from the Wear and their policy of regulating the supply to keep prices high actually encouraged development on the Wear, where the restrictions could not be imposed. The coal-trade and town of Sunderland, which had not been noticed by Camden, both grew rapidly. Its great opportunity to establish a firm footing in the London market came during the Civil War when supplies from Royalist Newcastle were interrupted. On the Wear, as on the Tyne, however, the coal was drawn from quite a small district, within a mile or two of the river between its bend at Chester and its entry into the post-glacial gorge cut across the limestone plateau to the sea.

Although the Wear district remained the chief addition to the mining area in the century and half following the death of Elizabeth, some extension of the area that supplied the Tyne coal-trade also became necessary as time went on. By the beginning of the eighteenth century the coal within reach of existing methods of mining had been worked out in many places on Upper Tyneside and the collieries were waterlogged. Foreseeing the impending exhaustion of the accessible coal in the existing mining area, certain coal-owners sought to strengthen their position by buying up leases for areas farther from the river in the western districts where large reserves of coal lay well within the known range of exploitation (about 60 fathoms). This policy inspired the formation in 1726 of a powerful combination of coalowning families known as the Grand Allies, who entered into an association to extend the mining field by securing large tracts of coal in north-west Durham. Thus we find a colliery viewer stating in 1738 that there were pits 8 miles from the river whereas 12 years earlier the farthest had been 5 miles from the river. Mines were developed in the Pontop-Tanfield district, and mining hamlets such as Dipton and Tantobie sprang up on the plateau between the Derwent and Team valleys, 8 or 9 miles from the Tyne. The joint resources and co-operative policy of the Grand Allies overcame the difficulties of establishing and working such long waggonway connections with the staiths. In spite of these extensions, however, the developed coalfield remained small, and industrial activity, although it was expanding, also remained strictly confined to the riverside and the coast. During the seventeenth century the salt industry was at its peak. Its chief centre was at the mouth of the Tyne, where just within the estuary mouth there were at one time 200 saltpans in operation at South Shields, employing about 1,000 men. The industry declined later in the eighteenth century, but the communities which it had supported found alternative sources of employment through the expansion of other industries, such as glass, pottery, shipbuilding and its ancillaries ; and these industries also added new settlements.

The largest concentration of industrial workers was near the Tyne bridge, the centre of the coal-trade. The glass industry had first been established on the Tyne in 1619 on a ballast shore just east of the mouth of the Ouseburn (St. Lawrence) and towards the close of the century and early in the eighteenth century other glasshouses were added in the Ouseburn district, and also on the south side of the river. Above the Ouseburn shipyards, roperies and the like lined the north bank of the Tyne as far as Sandgate, and during the eighteenth century several potteries were established near the river in Byker and Gateshead. Most of the works gathered east of the Tyne bridge but there was some development on a smaller scale farther west near the mouths of the Skinner Burn and the Team. On the Wear too, the flourishing coal-trade attracted industrial undertakings of similar type, while outlying industrial settlements came into being north of the Tyne at Seaton Sluice and Blyth. Seaton Sluice dates from the seventeenth century and owed much to the enterprise of the Delaval family (7). Their harbour works allowed the small salters' village to become a small port with a growing trade in coal and salt. Further improvements in the 1760's and the establishment of a bottle-glass factory and a copperas works added to the prosperity in spite of decline in salt-making. So too in the case of Blyth, of which Leland makes no mention and which is not shown on Speed's map in 1676. The opening of the waggonway from the Plessey pits to Blyth in 1709 revived the manufacture of salt and the coal-trade, and by the end of the eighteenth century both shipbuilding and rope-making were adding to the industrial employment.

All these industries, however, were more localised even than the coalmining. They were based upon the use of coal, the coal-trade, and water-transport. New industrial sites were occupied and new groups of workers' houses sprang up alongside, but their locations were still essentially of the same type—with few exceptions confined to the banks of navigable rivers or the coast within the outcrop coalfield.

The close association of industrial settlement with tidewater sites during the eighteenth century was relaxed somewhat in the

case of the iron industry (8). The use of Coal-Measure ore, sometimes actually worked with coalseams, and of water-power to drive forge-hammers were the bases of small-scale iron manufactures at a few scattered points in the coalfield, notably within the mining area of north-west Durham. On rapidly flowing burns at Beamish and Lunley there were forges whose workers lived in the time. Soon afterwards the manufacture of the heavier articles such as anchors and chains was transferred to Swalwell, to which point the Derwent was navigable. Winlaton continued to make nails, files, and edge-tools ; there were forges and a slitting mill on the river nearby (Winlaton Mill) and also higher upstream at Derwentcote and Blackhall Mill where steelmaking by the cementation pro-

Seventeenth- and Eighteenth-century Industrial Sites

adjacent hamlets of Beamish and Breckon Hill ; and the first blast-furnace to use coal in the North-East was established before 1750 at Whitehill on Chester burn, but it had been abandoned before the end of the century on account of the inadequacy of the water-supply upon which the blast depended.

The chief ironworking district, however, was the lower Derwent valley, where Ambrose Crawley brought over German workmen to establish his works at Winlaton in 1690 amidst the busiest mining district of that cess was carried on. These sites are near the modern centre of the steel industry at Consett. By eighteenth-century standards the Derwent colonies of ironworkers were large and attracted much attention. Arthur Young in 1770 described the works as ' supposed to be the greatest manufactory of its kind in Europe,' and in 1788 the striking change wrought by the appearance of industry here was described in the Universal Magazine :— ' Before Sir Ambrose settled his people the place (Winlaton) consisted of a few deserted

cottages, but now contains about 1,500 inhabitants, chiefly smiths.'

Even in the iron industry, however, the market provided by shipping and other industries on the river and the use of imported raw materials attracted some of the main establishments to navigable water, especially those making the heavier articles. It has been noted that this was so at Swalwell, and another instance is provided by the Team Works of the Hawks family at Gateshead. This began in 1747 with a few forges working up old iron brought by collier vessels as ballast and to supply the demand for anchors and chains created by the great increase in shipping. From small beginnings it grew steadily into an important concern by 1800.

The only manufacturing activities unrelated to coal or the coal-trade, and therefore in quite a different category in respect of location, were the textile and leather industries which were prominent features in the seventeenth and eighteenth century prosperity and growth of the old-established market towns. Small woollen mills and tanneries were usually present in these centres, while at Darlington the linen industry acquired a much more than local importance and employed most of the working population throughout the eighteenth century. After 1750 the worsted industry also grew rapidly at Darlington, while at Durham and Barnard Castle carpet-making was especially important, and Hexham was noted for its gloves.

Towards the end of the eighteenth century, the chief centre of coal-mining activity shifted definitely eastwards to lower Tyneside, the area of deeply buried coal east of the bridge. This area enjoyed great advantages of position for easy shipment, but it had hitherto lain untouched because the coal was too deep. With the application of the steam-engine to pumping and steady improvement in its powers (9) it at last became possible to open mines in the High Main coal here, and the expected premium upon more distant tracts of coal anticipated by the Grand Allies was cancelled.

Whereas in the old western districts there was stagnation or decline at the end of the century so that we find Eden in his *State of the Poor* (1797) remarking upon the depressed state of the industry in Tanfield parish, sinking was in full swing on lower Tyneside, and many of the new pits were within a mile of their staiths. The villages which grew beside them were practically on the river-banks, and are among the nuclei of modern Wallsend, Hebburn, and Jarrow. These deep pits were larger units, employing on an average from 300 to 400 men at the opening of the nineteenth century, whereas few of those working in the western districts employed more than half this number.

The trough of the Wallsend basin was approached also from the north where there were old workings along the High Main outcrop on Shiremoor. Extension southwestwards in the direction of the dip is commemorated in the name New York, one of the mining hamlets thus brought into being at the time of the American War. The tract of country north of the Tyne valley had until this time remained an extensive unenclosed moor, but it was then enclosed and new roads were laid out.

With the help of the steam-engine there was also considerable further growth of the Wear coal-trade during the course of the eighteenth century, though it remained focused upon the staiths on the reach of the river between Lambton Castle and Cox Green. Although the pits here were smaller than those of lower Tyneside they were on the whole somewhat larger than those of the western districts.

As compared with the distinct clotting of settlement in colliery villages which coal-mining enterprises produced on the coalfield, the eighteenth-century revival and expansion of the silver-lead mining in the Pennine dales produced little settlement that was either dissociated from farming or grouped in form. The miners in the dales were members of families who occupied scattered small-holdings, and as mining employment expanded these simply multiplied and encroached upon the moorland. Only at the local headquarters of the dales mining companies, where ore-dressing and smelting operations were carried on, did there appear clusters of dwellings that can be described as industrial settlements—Nenthead, Allenheads and Rookhope were eighteenth-century creations of this kind.

In conclusion let us summarise the extent of industrialisation at the time of the first Census in 1801. Most of the coalfield of to-day was still rural. Only where good household coal was easily mined within a few miles of tidewater did collieries, waggonways, and pitmen's houses appreciably alter the prevailing rural landscape. Even here industrial settlements were small and scattered except in the immediate vicinity of the river-banks, and outside these districts scattered outcrop workings of coal for local landsale scarcely affected the agricultural tone of countryside and population.

By far the largest concentration of population was at the Tyne bridge where Newcastle and Gateshead together accommodated some 43,000 people within the extent of the present local government boundaries. In Newcastle buildings crowded along the river-bank and

the steep approaches to the low stone bridge, rebuilt since the 1771 floods had swept away its predecessor. In central Newcastle, which Grainger was shortly to transform, meadows, gardens, orchards and the extensive grounds of Anderson Place survived within the walls, and open country began almost immediately outside. The annexe outside Sandgate where the keelmen lived had grown considerably, and Byker across the Ouseburn was a growing industrial suburb. But expansion beyond the walls on the north and west sides had scarcely begun. The suburb Westgate contained fewer than 700 people, while Benwell with less than 1,000, and Jesmond, Elswick and Heaton with only a few hundred each, were quite detached from the main built-up area. On the opposite bank the growth of Gateshead, Newcastle's industrial satellite and always its poor neighbour, had been concentrated along the main road as it approached the bridge, and along the river bank to the east. Gateshead Fell was still undivided common, where there were small groups of cottages inhabited by the workers at Carrs Hill pottery and the quarrymen who worked the grindstones.

Another clustering of industrial works supported a second urban concentration on the Tyne just within the rivermouth, where between the Narrows and the bend at Whitehill Point North and South Shields faced each other, each containing about 11,000 inhabitants. Both were essentially riverbank settlements with linear plans, confined to narrow terrace strips along the waterfront and backed by the steep valleysides.

Between these main groups and also on upper Tyneside there were other industrial works and pits, with dependent colonies of workers, for example at Howdon, Lemington, Blaydon, and Swalwell. Their industries by later standards were on a small scale, however, and they were still only small separate groups, between which the green fields came right to the water's edge. Some at least of the nuclear cells of modern Tyneside had appeared, but Tyneside was by no means yet a single conurbation. That process of multiplication and expansion which led to the coalescing of the riparian settlements belongs to the second half of the nineteenth century.

Whereas on the Tyne collieries and miners' rows intermingled with other industrial works and dwellings, geology caused the two to be segregated on the Wear. Colonies of keelmen on the riverbanks just below its great bend at Chester-le-Street, and the straggling pit villages attached to them by waggonways formed an industrial district quite clearly distinct from the rivermouth concentration. Beginning with potteries and boatbuilding yards at North and South Hylton, industrialisation was intensified downstream from Southwick and Pallion. Shipyards, glasshouses, limekilns, saltpans, roperies, and copperas works lined the river with housing behind. About two-thirds of the 25,000 inhabitants of this Wearmouth cluster lived on the south bank, and only since 1796 had the two components been connected by a bridge. In Northumberland Blyth with 2,000 inhabitants and Hartley with 1,600 were small outlying centres of industry and coal-shipment; but on the Tees, well beyond the southern edge of the coalfield, there was no iron industry yet, and coal was a small import not an export.

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CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES

NEWCASTLE MEETING, 1949

In accordance with the arrangements made by the Corresponding Societies Committee, the Conference of Delegates during the Annual Meeting of the Association at Newcastle upon Tyne was held in two sessions, the first on Thursday, September 1, when Dr. G. F. Herbert Smith, C.B.E., delivered his Presidential Address and the second on Monday, September 5. Both sessions were held at King's College. The following is a report of the proceedings.

First Session: Thursday, Sept. 1, 1949.

THE PRESERVATION OF NATURE

ADDRESS BY

DR. G. F. HERBERT SMITH, C.B.E.

PRESIDENT OF THE CONFERENCE OF DELEGATES

I. INTRODUCTION

1. During the past twelve months a gratifying and, one might almost say, an astounding advance has been made at home and in the world at large in the recognition of the need for the preservation of nature and for taking measures for bringing it about. In this country the Government have established the Biological Service with the Nature Conservancy to supervise its operations, and as the result of the International Conference jointly convened by the French Government and Unesco at Fontainebleau in France the International Union for the Protection of Nature was constituted with its seat at Brussels. It is therefore fitting that at this Conference we should pause and take stock of what has been accomplished after many years of disappointment and frustration, and should look back over the past and trace the course of events. With such apparent ease has the goal been won that without some historical study it would be difficult to realise what steady and unremitting effort was required to produce this happy outcome.

2. The importance of preserving nature was not generally appreciated until comparatively recent years. Certainly up to the close of the nineteenth century no fear was felt—not even during the industrial revolution, when through lack of provident foresight so much harm was done—that no matter what man chose to do to the earth's surface he himself would suffer no hurt. In our country so large a proportion of the inhabitants are urban dwellers that it needed the disruption caused by the Second World War to make them realise that the food to which they had become accustomed and expected to have at their command did not automatically reach the shops, but had to be grown and garnered somewhere. The story of the child removed for safety to the country, who was surprised to find that milk was provided by cows and did not originate in bottles is probably founded upon fact. In a crowded country like ours the demands on the land for many purposes, all in themselves estimable, constitute a difficult problem, and a watchful eye is needed to assure that, if possible, in new schemes nothing of scientific importance shall be destroyed; in this respect local societies are obviously in a position to render valuable assistance.

II. OLDEN TIMES

3. From the evidence provided by geological investigations we know that at various epochs in the history of the Earth the balance of nature has varied in character and at times has varied considerably, but these changes have proceeded from natural causes. To early man the idea that nature was in need of protection from himself would have appeared to be a grim jest, if he were mentally capable of appreciating such a vein of humour. Cowering as he did in the dim recesses of natural caves and rarely venturing forth until driven by the incipient pangs of hunger, he was not physically capable of doing harm to the surroundings in which he happened to be placed, and would have regarded as fantastic the conception that sufficient food might not be available for his modest requirements. Even when civilisation had dawned and man had learned the

rudiments of husbandry he could have had no suspicion that there might be a limit to the density of population in any region. Otherwise the scribe would not have written the words in the Bible which are translated thus : ' And God blessed Noah and his sons, and said unto them, Be fruitful, and multiply, and replenish the earth ' (Genesis, ix. 1). Nature was, indeed, regarded as prolific and never failing. Thus Horace, who lived from 65 to 8 B.C., wrote : ' If you drive nature out with a pitchfork, she will soon find a way back ' (*Naturam expelles furca, tamen usque recurret.* Epistles, I, x, 8), with which statement the suburban gardener would probably agree ; but had he known of bulldozers or tracked-vehicles he would have realised that they could succeed where the pitchfork failed.

4. We know from the relics left in the Earth's crust that many species of plants and animals have come into being, flourished for a while and finally disappeared. The cause of their extinction was always natural, and was due, for instance, to changes in the climate or in the Earth's crust. It is only within comparatively recent times that species have been exterminated by man or through his agency. While man had only his puny strength at his disposal he could do little harm to the life around him, and fitted in well with his environment. The case was very different when he was able to provide himself with weapons, gained the service of domesticated animals and, above all, commanded the use of mechanical power. He then became the most destructive of living species. The first species, the disappearance of which attracted the notice of the civilised world, was the dodo, a large bird, of which allied species formerly inhabited Mauritius (*Raphus cucullatus*) and Reunion (*Raphus solitarius*). So safe and unmolested had it been that it had completely lost the power of flight. Then came man, who either himself wantonly destroyed it—for its flesh, no matter how treated, could not be made palatable—or allowed it to be attacked by the animals, particularly hogs, which he imported into the islands. The last survivor is believed to have perished in 1681. To be as extinct as the dodo has passed into a proverb. So little interest did the unwelcome visitors take in the birds that not a single specimen has been preserved for us, and our knowledge of them is based upon drawings and bones which have been found.

5. No criticism can be justly levied when drastic reduction in the number of animals or plants are necessary for the safety of man himself or the protection of his food or water supplies ; but such reduction may be carried beyond reason through ignorance or carelessness. Thus the bison (*Bison bison*), which once roamed in immense numbers over the extensive prairies of North America, was very nearly exterminated by the end of the nineteenth century owing to the rapid exploitation of the country brought about by railway development. Happily by then the civilised conscience had been aroused and reserves were established both in the United States and in Canada for its protection ; sufficient numbers were left for its healthy survival. The corresponding European species, *Bison bonasus*, which formerly flourished in all the large forests of the central continent, is not in so happy a position ; it is believed to survive in small numbers in reserves in the Caucasus.

III. Reservation Areas

(i) *Abroad*

6. So much has been accomplished in creating nature reserves and those of large size known as national parks in various countries that limitations of space as well as absence of complete information permit of only a brief outline of the present position. The United States of America took the lead in this respect. As the regions to the west were opened up the importance of reserving selected areas for the education and enjoyment of the public was realised in good time. When pioneers penetrated into the north-west of the State of Wyoming they were so deeply impressed by the magnificent scenery that they decided that it would be wrong to exploit the area for private benefit and that it should be reserved for the people for all time ; so in the words of the Act of Congress of 1872 it was established ' as a pleasuring ground for the benefit and enjoyment of the people.' Although this, the Yellowstone National Park, was the first of what were henceforth known as national parks, it was not the first of such areas in public ownership. Eight years earlier, in 1864, the Yosemite Valley and the Mariposa Big Trees were granted to the State of California as an open space. Many years later, in 1890, it was retrieved by the Federal Government, and together with an adjoining larger piece was created a national park. The earliest nature reserve was one at Hot Springs in Arkansas, which was set aside as far back as 1832. In the United States there are now no fewer than 27 national parks, 84 nature monuments, and 58 other reserves, besides many sanctuaries. They are supervised by the National Parks Service of the Department of the Interior. Canada possesses some fine national parks, notably the Jasper and the Banff in the Rocky Mountains ; there are 19 national parks altogether and many sanctuaries as well. Under the stimulus of the Pan-American

Union there has of recent years been considerable awakening in the South American countries to the need for national parks and nature conservation in general.

7. One of the largest of the national parks in the world is the Kruger in South Africa, which was developed from the Sabi reserve that was founded in 1898 by President Kruger. With a width of about 50 miles, it extends for some 220 miles along the border with Portuguese East Africa. There are also four other national parks, namely the Kalahari, Mountainzebra, Bontebok and Addo. A Scientific Advisory Council for National Parks and Nature Reserves has recently been appointed by the Union Government. A famous national park is the one in the Belgian Congo which was established in its present form in 1929 and is named the Albert National Park after the then King of the Belgians. In addition there are two more, the Kagera and the Garamba. The general control of the areas is entrusted to the Institute of the National Parks of the Belgian Congo. The Administrative Commission is international in character, having eight foreign members as well as sixteen Belgians. Several national parks exist or are contemplated in East Africa, for instance the Serengeti National Park and a small one near Nairobi. Various small reserves exist in Australia, where nature conservation is the concern of the constituent States, and New Zealand possesses the Otari open-air plant museum near Wellington as well as many landscape reserves.

8. In Europe the most important area is the Swiss National Park in the Lower Engadine, which was established in 1912. It is remarkable in being a nature reserve of the strictest kind. No one is allowed to stray from the highroad that passes through it or to visit the area except by special permission for the purpose of study. Natural forces operate without let or hindrance. Even old trees are not felled, but are allowed to fall to the ground and to decay naturally. It is therefore the site of most valuable research. The Gran Paradiso National Park in northern Italy provides a refuge for the rarer Alpine animals. France possesses a great reserve in the Camargue between the mouths of the Rhone, which is noteworthy for the large number of waterfowl that live there unmolested. Nature reserves exist in many other countries, for instance the Netherlands, Norway, Sweden, Germany, and Spain.

(ii) *At Home*

9. Of all the constituents of the animal kingdom birds are the most noticeable and the most attractive. It is therefore not surprising that in Great Britain legislation for their protection was introduced many years ago. The principal Act dealing with wild birds other than those regarded as game, namely grouse, partridge, pheasant and ptarmigan, is the Wild Birds Protection Act of 1880. There have been many amending Acts, but the position is still not altogether satisfactory, and further legislation, which may be of a comprehensive character and include all forms of wild life, is required. The Royal Society for the Protection of Birds, which was founded in 1889, has been indefatigable in safeguarding the rarer species, and has acquired reserves for the purpose. Equally attractive in another way and of greater appeal to human acquisitiveness are wild flowers. With the rapid growth of private and public transport in the twenties the recession of the more attractive wild plants, such as primroses and bluebells, in the neighbourhood of large centres of populations and especially round London began to arouse grave concern. In 1925 the Society for the Promotion of Nature Reserves addressed a circular to all county councils, drawing attention to the need for by-laws for the protection of wild flowers, and a little later produced a poster to enlist public support in the campaign. In 1931 the Council for the Preservation of Rural England established the Wild Plant Conservation Board, composed of representatives of interested societies. By means of posters and leaflets the public were kept alive to the harm resulting from indiscriminate uprooting of wild plants. Many county councils were induced to adopt under Section 249 of the Local Government Act, 1933, suitable by-laws, of which the latest form was the following : ' No person shall, unless authorised by the owner or occupier, or by law, so to do, uproot any ferns, primroses or other plants growing in any road, lane, roadside waste, roadside bank or hedge, common or other place to which the public have access.' The defect of this and other forms of the by-law is their inapplicability to private woodlands, which are in even greater need of protection. At present in these instances proceedings can be taken only under the Malicious Damage to Property Act, 1861, which, however, is of little use for the purpose, because the heavy penalties involved militate against a conviction. It is therefore to be desired that wild plants will be included in any protective legislation that may be enacted. The difficulty of devising a formula which would stop wholesale depredations and not apply to harmless picking is obvious ; much of the trouble would be countered if unauthorised sale or offering for sale were made illegal.

10. An important step towards the preservation of both the natural and the humanistic

features of the countryside was taken in 1895 by the foundation of the National Trust for Places of Historic Interest or Natural Beauty, largely as the result of efforts made by Miss Octavia Hill, Sir Robert Hunter and Canon Rawnsley. Still another important epoch opened in 1903, when, aghast at the appalling slaughter of game animals occurring in East Africa, a number of interested persons banded themselves into an association which took the name of the Society for the Preservation of the Fauna of the Empire. Besides rendering great service in safeguarding species of mammals threatened with extinction the Society has taken part in general movements for the protection of nature. With the view of preventing the threatened disappearance of rarer species of plants or animals or of interesting associations of them the Society for the Promotion of Nature Reserves was founded in 1912. The original intention was to stimulate the acquisition of areas of natural history interest and to hand them over to the National Trust or other bodies with similar objects, and in this way the Trust came into possession of Blakeney Point, with Scolt Island, in Norfolk and of the Farne Islands off the coast of Northumberland. The Society was, however, constrained to retain possession of the extensive reserve in what was formerly the Huntingdonshire fens. It owns also the Coward Memorial Reserves in Cheshire as well as minor sites, but they are managed independently; in addition it holds on lease Meathop Moss and a large part of the adjoining Catcrag Moss in south Westmorland. As is stated below, the Society has been actively engaged in promoting the general movement, both nationally and internationally, for the preservation of nature. Mention should be made of the energetic and enterprising Norfolk Naturalists' Trust, which was founded by Dr. S. H. Long in 1926. It owns many important reserves in the county and acts as agent for the National Trust in managing the latter's reserves in it. Recently the two bodies joined forces for the acquisition of Horsey and Hickling Broads. A similar body, the Yorkshire Naturalists' Trust, was formed in 1946, with the immediate object of safeguarding Askham Bog, near York, as a nature reserve. The recent formation of the South Downs Preservation Trust and the Lincolnshire Naturalists' Trust may be noted. Indeed, the formation of such trusts in other parts of the country, in order to assure the safety of areas of at least local interest, is much to be desired.

11. A new epoch dawned by the inception in 1926 of the Council for the Preservation of Rural England, followed by the Association for the Preservation of Rural Scotland in 1927 and the Council for the Preservation of Rural Wales in 1928. It was due to representations by the first-named body that the Government Committee on National Parks was appointed in 1929. Among the witnesses was the British Correlating Committee, which accompanied its evidence with a list of areas and sites in the country that should be preserved in their existing condition because of their wildlife or geological interest. The report of the Government Committee, which appeared in 1931, recommended the establishment of a system of national parks and nature reserves, but owing to the economic crisis which developed at that date no action was taken, and it appeared as if the movement had come to a complete standstill. For that reason the Councils for England and Wales in 1933 jointly set up the Standing Committee on National Parks, which was composed of representatives of all the various bodies that had submitted evidence to the Government Committee. The corresponding body for Scotland, the Scottish Council for National Parks, did not come into being until 1942. The Standing Committee was active in many different ways in maintaining public interest in the matter until with the outbreak of the Second World War its operations temporarily ceased.

12. In spite of the concentration of the national effort upon the prosecution of the war, problems that would necessarily at some time have to be considered were not overlooked, and a Committee of Land Utilisation in Rural Areas, which reported in 1942, was appointed. The report included recommendations for the establishment of national parks and nature reserves and the preservation of geological monuments. About the same time under the aegis of the Society for the Promotion of Nature Reserves a conference of delegates of interested bodies was convened to consider the question of nature preservation in post-war reconstruction. In the report which appeared in 1941 it strongly advocated the establishment of national parks and nature reserves and the recognition of areas, which because of their unspoilt state should be conserved in their existing condition. In response to official request the Conference in 1942 appointed the Nature Reserves Investigation Committee. The Committee first devoted itself to preparing a detailed report, which was published in 1943, on the general policy that should be adopted as regards nature conservation in Great Britain, and then realising that a natural history survey was certain to be required, set up a series of local committees for the purpose to cover England and Wales. The result of their labours was embodied in two reports, dealing respectively with

geological features and with wild life, which the Society published for the Committee late in 1945. Scotland was not included in the survey because the Committee was authoritatively, though, as it proved, mistakenly assured, that arrangements had been made for this undertaking.

13. Meantime, in 1944, Mr. John Dower was commissioned by the Ministry of Town and Country Planning to review the question of national parks in England and Wales. The careful report which he compiled stimulated so much public interest that the Ministry were impelled to go further and appoint a Committee to go into the subject in fuller detail and ancillary Committees to consider the allied subjects of the conservation of wild life and the provision of footpaths and access to the countryside. The various reports appeared in 1947. The one on national parks followed Mr. Dower's report very closely, and that on the conservation of nature in England and Wales practically endorsed the recommendations contained in the reports of the Nature Reserves Investigation Committee. Concurrently, in 1944, a Scottish National Parks Survey Committee was appointed, and in its report, which was published the following year, recommended various areas in Scotland as national parks or nature reserves. The Scottish National Parks Committee and the Scottish Wild Life Conservation Committee were correspondingly appointed in 1946 to study the two aspects in fuller detail, and a joint report was issued in 1947. The Government were not slow, considering the magnitude of the task, in implementing, so far as was deemed advisable, the recommendations of the various Committees. In particular, late in 1948, the Biological Service was instituted, and, soon after, the Nature Conservancy to supervise it. Finally, the National Parks and Access to the Countryside Act, 1949, is concerned with the National Park Commission, National Parks, Nature Conservation, Public Rights of Way, Access to Open Country and ancillary matters. It should be noted that the nature conservation part applies to the whole of Great Britain. The criteria for national parks are (a) their natural beauty, and (b) the opportunity they afford for open-air recreation, having regard to both their character and to their position in relation to centres of population. The definition of nature reserve is commendably wide : it is taken to mean land managed for the purpose (a) of providing, under suitable conditions and control, special opportunities for the study of, and research into, matters relating to the fauna and flora of Great Britain and the physical conditions in which they live, and for the study of geological and physiographical features of special interest in the area, or for both those purposes. It may be anticipated that the Biological Survey will welcome local aid in dealing with the problems of the corresponding regions.

IV. International Co-operation

14. The serious diminution in the numbers of certain animals in certain regions called for some form of agreement among the nations concerned if they were to survive. Thus, in 1911 a convention was entered into by the United States, Great Britain, Russia and Japan, whereby pelagic hunting of the Alaska fur-seal was prohibited and the herd on the Pribilof Islands was vested in the United States, Canada and Japan sharing in the harvest to the extent of 15 per cent. each. The reduction in numbers, almost to extinction, of large whales in Arctic waters and the diminution in numbers of those in the Antarctic called for an understanding between the nations engaged in hunting them. By a convention, agreed to at Geneva in 1931 and brought into force in 1935, the capture of a right-whale, an immature whale, a female accompanied by a young one was prohibited. The London Conference of 1937 fixed an annual close season of nine months for pelagic whaling and of six months for whaling from shore stations, while baleen-whales were protected in specified areas and right-whales and grey-whales were protected always ; no blue-whales less than 70 feet in length were allowed to be killed, and the minimum length was 55 feet for fin-whales and 35 feet for humpbacks and sperm-whales. Further provisions were made at the Conferences of 1938 and 1939, the most important being the closing of the Arctic to whalers. It may, however, be questioned whether in the absence of serious policing these measures are really effective. Whales did enjoy a respite during the Second World War.

15. Migrant birds obviously need some kind of international protection, because it is of little use one country sparing them if they are destroyed on their way across another. As the result of a conference of influential ornithologists in London in 1922 the International Committee for Bird Preservation, with separate sections for the constituent countries, was established. For some years little was done except to talk, pass hopeful resolutions and issue reports, until in 1934 at the International Ornithological Congress at Oxford it was unanimously agreed that the International Committee should be reorganised so as to become more active and effective. The British Section led the way by a complete reorganisation of itself. Since then the activities and influence of the

Committee have increased beyond all expectations. A European and a Pan-American Division have been formed, and thirty-five nations are represented on the Committee. One of the most important activities of the European Division has been the revision of the original convention of birds useful to agriculture which was drafted at the Conference at Paris in 1902, since experience proved it to be founded upon unsound principles. At the Conference of the European Sections at Paris in 1947 a completely revised convention under the title of International Convention for the Protection of Birds was approved. The British Section has also been active at home, and played a significant part in securing the passage of the Quail Protection Act, 1937, and the Wild Birds (Duck and Geese) Protection Act, 1939. It took the lead in the inquiry into the status of the wild-fowl of Europe, and in 1947 the other Sections concerned agreed that all the relevant information should be sent for correlation to the International Wildfowl Research Institute at Tring.

16. So intimately is landscape linked with the natural features composing it that it is perhaps not surprising that the first suggestion for the need for international co-operation in the general protection of nature was made at the International Congress of Public Art which was held jointly with the International Literary and Artistic Association at Liège in 1905, when there was adopted a resolution, moved by Mr. Raoul de Clermont, that measures for the creation of national parks should be taken, in order to save from destruction particular plants, animals and minerals. In 1909 at the International Congress for the Protection of Landscape it was urged by Mr. de Clermont and Mr. Louis Ternier in their report on the protection of fauna and flora in relation to landscape that steps should be taken to preserve species threatened with extinction. In the following year, 1910, at the Congress of the International Literary and Artistic Association at Luxemburg Mr. de Clermont secured a vote for a motion of wider scope, namely, to effect uniformity, as far as possible, in legislation relating to nature monuments and establishing an international federation of the societies interested in them. At the Congress of the same Association at Paris in 1911 he submitted a proposal for a convention to create an international office for the protection of landscape and nature, and in 1913 at the succeeding Congress at Scheveningen he secured a vote for the creation of a permanent commission and office with the object of collating documents and information generally about the protection of natural sites and monuments. Although the trail here followed faded out and apparently led nowhere, publicity of some value resulted, which probably had effect upon the parallel efforts made elsewhere.

17. Meantime, at the Eighth International Congress of Zoology held at Graz in 1910, Dr. Paul Sarasin urged the creation of an international commission for the protection of nature throughout the world. The proposal was favourably received, and a provisional committee was formed to prosecute the matter further. In the following year, 1911, the Swiss Federal Government were approached with the view of setting up an international commission, but they decided that they could not do so merely of their own initiative, but that they should invite an international conference to discuss the proposal. The conference was held at Berne in 1913, and was attended by the representatives of seventeen countries. After lengthy deliberations it was unanimously decided to approve of an Act of Foundation of an Advisory Commission for the International Protection of Nature with its seat at Basle ; Dr. Sarasin was nominated for the presidency. A sufficient number of nations ratified the Act of Foundation to enable it to come into force the following year, 1914, but owing to the outbreak of the First World War it failed to function. Immediately on the restoration of peace Dr. Sarasin communicated with the members of the Commission, and inquired whether they agreed that (1) the Advisory Commission still existed, and (2) whether it should adhere to the League of Nations. The replies to the first question were without exception in the affirmative, but varied as regards the second. Inasmuch as the adherence of the Advisory Commission required initiating by its founder, the Swiss Federal Government, representations to that effect were made, but after full discussion the Federal Council came to the conclusion that the time was inopportune, since so many more important questions claimed the attention of the country and of the world generally, and decided to take no action. At the International Congress for the Protection of Nature held at Paris from May 31 to June 2, 1923, Dr. Sarasin gave an account of the course of events as regards the Advisory Commission, and moved a resolution, which was unanimously adopted, to the effect that the Swiss Federal Government should restore activity to the Commission either by convening an immediate meeting of it at Berne or by securing the intervention of the League of Nations. Nothing, however, was done, and with Dr. Sarasin's death in 1929 the stimulus of his energetic personality passed away.

18. The torch which fell from Dr. Sarasin's weakening hand was grasped by Dr. P. G.

van Tienhoven, and steadily and zealously borne forward. He was a delegate from the Netherlands to the Congress in 1923, and from his experience formed the opinion that the spasmodic effects of such international gatherings at intervals of years served little useful purpose, and that some form of machinery for maintaining activity in the intervening periods was necessary. He discussed the matter with other delegates, among whom was Viscount Ullswater, then President of the Society for the Promotion of Nature Reserves, and in consequence later in the year, on November 2, participated in an informal discussion in London. His suggestion was the appointment of an international committee to meet annually between the congresses with the object of exchanging information about the creation of reserves and cognate subjects. The suggestion was favourably received, and as the result a meeting of representatives of various British national societies concerned with the protection of nature was held under the auspices of the above-named Society at the British Museum (Natural History) on January 14, 1924, at which it was decided to establish a committee of such representatives under the title of Central (later British) Correlating Committee for the Protection of Nature ; its functions were to be wholly advisory in character, questions submitted to it being referred to the constituent society, within whose scope they appeared best to fall. At the meeting of the Committee on July 14, 1924, Dr. van Tienhoven and Mr. Ad. Burdet, of the Netherlands, and Mr. Jean Delacour, of France, were present, and the question of international protection of nature was debated ; the conclusion come to was that some form of co-operation was much to be desired, and the establishment in every country of a committee similar to the one in Great Britain would constitute a significant step to that end. Efforts were accordingly made, and thanks largely to Dr. van Tienhoven's initiative the Netherlands Committee for the International Protection of Nature and the French Permanent Committee for the Protection of the Colonial Fauna were formed in 1925, and the Belgian Committee for the International Protection of Nature followed early next year ; but otherwise the response was tepid. On April 9, 1926, Dr. van Tienhoven and Dr. J. M. Derscheid attended a meeting of the British Correlating Committee, and joined in a discussion on the proposal for an international federation and a bulletin. Definite decision on the proposal was deferred by the Committee to the annual meeting on May 31 of the same year, when it resolved that as at present advised it saw no reason for taking any action in the matter. The cause of this negative attitude appeared to have been the feeling that no effective result would ensue unless correlating committees were formed in every country, and of that event there was little likelihood. Except for consideration of the evidence to be submitted to the Government Committee on National Parks in December 1929, the Committee had little further business to transact, and, as there appeared little reason for its continuance, it was wound up in 1935. The fate of that Committee may seem odd in view of the recent formation of a similar Committee with a far more promising future ; the evident explanation is that the time then was not ripe for general co-operation in the international field as regards the protection of nature.

19. Because direct progress towards some form of international organisation for the protection of nature was sluggish and discouraging, the matter was raised at various meetings of the International Union of Biological Sciences during the period 1925 to 1928. Finally in 1928, it was proposed to form in the Union a commission for the international protection of nature for the purpose of continuing the work begun by Dr. Sarasin. In the course of the discussion that followed the steps that had already been taken in this direction were recounted. It was decided that, while the time was not ripe for a federation or union, it was desirable to establish provisionally an International Office of Documentation and Correlation for the Protection of Nature, having as its object the collection, classification, publication, and circularisation to interested persons, documents, laws, general information, and all kinds of statements concerning the protection of nature. Under the revised title of International Office for the Protection of Nature it began its activities at Brussels in 1930 with Dr. J. M. Derscheid as Director ; by Royal decree of July 7, 1934, the Office was granted legal status. In 1935 the Office was reconstituted with more of an international flavour, and Mrs. Tordis Graim was appointed Director. Up to the outbreak of war a considerable number of publications were issued despite the limited extent of the funds available. In 1940 the Office was transferred to the Colonial Institute at Amsterdam, and at the same time Dr. van Waterschoot van der Gracht replaced Mrs. Graim as Director upon her compulsory return to her native country, Norway. He died in 1943, and in the absence of staff and funds the Office was closed. After the end of the war limited activity was resumed with Dr. J. H. Westermann as Acting Director. He retired when the Office was removed back to Brussels in September 1948 and linked with the newly

formed International Union for the Protection of Nature.

20. When the numbness engendered by a long and tragic war gradually wore off and thoughts turned from destruction to conservation an initial step towards the consideration of international co-operation was taken by the Swiss League for the Protection of Nature. Naturalists from various countries in Europe were invited to visit the Swiss National Park and Reserves during the period June 30 to July 7, 1946, and the opportunity was seized for an informal discussion on the international aspect. The principal conclusion reached was the following : in order to facilitate the co-operation of national societies concerned with the protection of nature and with the conservation of scenic beauty, it was desirable that there should be an active international organisation, having a fully representative character, a budget in keeping with its importance and appropriate statutes. Encouraged by this favourable response, the Swiss League proceeded to issue invitations widely to governments, governmental institutions and appropriate national societies in various countries to attend a conference at Brunnen from June 28 to July 3, 1947. Dr. Ch. J. Bernard, President of the Swiss League, was elected President of the Conference. There was at first a fundamental difference of opinion whether to resuscitate the Advisory Commission of 1913, as was favoured by the Swiss League or whether to inaugurate with the aid of Unesco an entirely new International Union. The alternatives were carefully and fully considered by the Committee appointed to draft the constitution, and the latter view prevailed. The constitution was drawn up accordingly, and with slight amendment was approved by the Conference. In due course a copy of the constitution was forwarded to Unesco by the Swiss League as agent for the Provisional Union.

21. After some hesitation the General Assembly of Unesco agreed to sponsor a conference in 1948 to consider the question of an International Union, and eventually it was arranged by the French Government to take place in the National Palace of Fontainebleau from September 30 to October 7, 1948. Invitations to governments were issued by the French Government and to appropriate organisations by the Swiss League. Altogether about 120 delegates, representing thirty-two countries and eight international organisations were present. Dr. Bernard, who had presided at Brunnen, was elected President of the Conference. An early step was to appoint a Juridical Committee to draft a constitution. The constitution so drafted was with a few minor amendments approved by the Conference, and was signed by the delegations, in most instances with reservation for subsequent ratification by the constituent bodies. The new International Union for the Protection of Nature was accordingly established on October 5. At the first meeting of the General Assembly which followed Dr. Bernard was elected President and Mr. J. P. Harroy Secretary-General and Treasurer, and the invitation of the Belgian Government for the seat to be at Brussels was accepted. An Executive Board was appointed with full authority to carry on the business of the Union until the next meeting of the General Assembly in 1950. The Executive Board met at Brussels on March 18 and 19, 1949. An important item of business was the nomination of experts to be invited by Unesco to attend the International Technical Conference in the United States in August 1949.

V. The Future

22. Some quarter of a century ago a sapling was planted, but failed to take root, and withered and died ; last year a similar sapling was planted, which has already taken root with a promising augury for its future. It is probable that the principal matter which will occupy the attention of the International Union for the Protection of Nature will be not so much the safeguarding of species of plants or animals threatened with extinction by man's interference with their habitat as the maintenance of the balance of nature. Ever since man learned to clothe himself, to provide himself with habitation, light and heat, to cultivate the soil, and above all to enlist mechanical aid he has intruded more and more into every part of the world with often unforeseen and even disastrous results. Sometimes such results have been due to carelessness, as for instance the introduction of the rabbit into Australia, and sometimes to lack of foresight, as for instance the introduction of the potato to the delighted satisfaction of the Colorado beetle. In fact, the problem is to achieve a symbiosis between man and his environment wherever he may be. If war and other disturbances cease and if hygiene and living conditions continue to improve and medical science to advance, the population will tend to increase, whereas the extent of the cultivatable soil and its fertility not only do not grow, but even show a serious fall ; it is clear that in course of time a crisis is inevitable. It may be recalled that the question of food supply was the chief topic discussed by Sir William Crookes, F.R.S., in his Presidential address to the British Association at the Bristol meeting in 1898, just over a half-century ago. He then took a very

pessimistic view of the position, and feared lest within a very limited number of years wheat-eaters would go short, unless they were prepared to eat Indian corn or rye bread. Owing, however, to unexpected improvement in wheat strains his forebodings were not realised, and it is only now that owing to the extensive disruption of cultivation due to prolonged disturbances over so much of the globe that the problem of food resources has become serious. By what means and in what way the size of the population may be related to the food available cannot be forecast with confidence, because it is uncertain whether the limit of food production may not be considerably extended as the result of improvements in agriculture and discoveries in organic chemistry. Whatever difficulties and problems the future may present it may, however, reasonably be felt that man's mental capacity will prove equal to coping with them.

VI. International Conventions

23. As an addendum to the narrative of the events that led to the inception of the International Union for the Protection of Nature mention may be made of the conventions for the protection of plants and animals which have been adopted for two extensive regions of the globe : Africa and the Americas. At the International Congress for the Protection of Nature which was held at Paris in 1931 the two British delegates produced a letter from the Prime Minister to the effect that, if it were the wish of the Congress, the Government might invite the African Powers to send delegates to a conference in London with the object of discussing and determining what measures were desirable for safeguarding species of animals and plants which were threatened with extinction, and to what species and in what degree such measures should be applied. The letter was warmly welcomed, and was regarded as a significant step forward towards the goal which the Congress had in view. The British Government acted with commendable promptitude, and the Conference duly took place in London in 1933, with the Earl of Onslow as chairman. Observers from the United States of America, the Netherlands (including the Netherlands East Indies), and India were present by invitation. In the resulting Convention, which after ratification came into force in 1936, careful measures were specified, which had the object of effecting the protection required. The principal ones were the establishment of national parks and strict nature reserves (or, if temporarily impracticable, the selection of areas suitable for them), intermediate zones round them, and reserves for particular species inadequately protected ; and regulations for hunting and trapping animals outside those areas and the prohibition of certain objectionable methods for those purposes. At the same time the traffic in trophies and animal products, which had been largely responsible for the diminution in the number of certain species, was to be brought under control. The annexes to the Convention comprise (A) species which should enjoy complete protection, and (B) species which, though not needing complete protection, should not be hunted, killed, or captured except by special licence.

24. In the Convention a national park is defined as ' an area (a) placed under public control, the boundaries of which shall not be altered or any portion be capable of alienation except by the competent legislative authority, (b) set aside for the propagation, protection, and preservation of wild animal life and wild vegetation, and for the preservation of objects of aesthetic, geological, prehistoric, historical, archæological, or other scientific interest for the benefit, advantage, and enjoyment of the general public, (c) in which the hunting, killing, or capturing of fauna and the destruction or collection of flora is prohibited except by or under the direction or control of the park authorities. In accordance with the above provisions facilities shall, so far as possible, be given to the general public for observing the fauna and flora in national parks.' A strict nature reserve (natural, in the original text) is defined as ' an area placed under public control, throughout which any form of hunting or fishing, any undertakings connected with forestry, agriculture, or mining, any excavations or prospecting, drilling, levelling of the ground, or construction, any work involving the alteration of the configuration of the soil or the character of the vegetation, any act likely to harm or disturb the fauna or flora, and the introduction of any species of fauna and flora, whether indigenous or imported, wild or domesticated, shall be strictly forbidden ; which it shall be forbidden to enter, traverse, or camp in without a special written permit from the competent authorities ; and in which scientific investigations may only be undertaken by permission of those authorities.' It will be noticed that the safeguarding of animals and plants is the principal object of a national park and the enjoyment of the public occupies a subsidiary place, contrary to the position at home where its main purpose is to be kept and made accessible for public enjoyment and open-air recreation.

25. A very similar Convention was considered and adopted at the Pan-American Scientific Conference at Washington in 1940,

and became effective in 1942. In the definition of a national park the protection and preservation of superlative scenery is interpolated, and strict wilderness reserve is the term used instead of strict nature (or natural) reserve. In 1936 the initial steps were taken by the British Government for a conference on similar lines to deal with Australasia to be held in 1939, but the war intervened, and in view of the political changes in that region its happening in the near future is most unlikely. Meanwhile, the programme of the International Union for the Protection of Nature includes the preparation of a world convention.

At the close of the address there was a general discussion in which several delegates participated. It was apparent that many local societies were fully cognizant of the dangers as well as the pleasures of National Parks and Preserves. A warning note of a psychological character was struck by one delegate. He experienced, in connection with his duties under the Council for the Promotion of Field Studies, a curious factor. Pupils who had been taught Biology at school and who had been taken on excursions into the country in that connection had sometimes developed the notion that they were a privileged class of person. Consequently they went collecting, but on their return left the material collected to lie rotting. Local societies had a duty to *preserve* natural objects, collecting only material that was to be used.

Forty-three delegates attended this session, ten more than at the corresponding meeting at Dundee. Adjourning for tea the delegates continued their discussions in an informal atmosphere.

Second Session : Monday, September 5, 1949.

The second session began with a discussion on Museums and the Public, which was opened by Dr. W. E. Swinton and Dr. D. A. Allan Among the points developed were the following. The hours at which Museums were open to the public was of great importance. It was little use having them open when the public was at work, if these institutions were to give their full value to the community where they were situated. Late opening, conducted tours round the exhibits and a useful selection of the material in the Museums should be obligatory. The anatomy of the Museum was also most important; and well arranged, well labelled selected specimens ought to be displayed *at eye level*, not on the floor or attached high up on the walls. Neither should floors be polished. The opening contributions were followed by lively discussion.

Professor H. R. Hewer then described the work of the Ray Society and illustrated his talk with an exhibition of some past volumes and proofs of forthcoming volumes published by the Society. The remainder of the session was taken up with the showing of scientific films, with an interval for tea. The first three films were The Conquest of the Dry Lands, Soil Erosion, and Tube Wells. By a happy coincidence two of these subjects had been referred to by Sir John Russell in his Presidential Address to the Association and this added to their interest.

The last film entitled The Function of the Ear in Health and Disease demonstrated an extraordinary series of experiments, tests and anatomical operations. The photography and micro-photography in colour and sound showed what recent medical research in this field had accomplished. The demonstration of this film was made possible by the generosity of the University of Chicago and the Medical Film Guild of New York.

Social Functions.

A dinner was arranged for delegates on Saturday, September 3. For a variety of reasons it was not well attended, but those who were present felt that they had had a profitable meeting and hoped that such a feature might continue to be one of the fixed items of the programme of future Conferences.

On Tuesday, September 6, the delegates, together with other members of the Association, were guests of the Natural History Society of Northumberland, Durham and Newcastle upon Tyne at an evening conversazione in the Hancock Museum. The delegates who were received by the President of the Society, His Grace the Duke of Northumberland, and Her Grace the Duchess, spent a happy and profitable evening as the guests of one of the oldest of the Corresponding Societies of the British Association.

Recommendations.

Arising from discussion at the Conference, two recommendations were sent forward to the Council of the Association for consideration :

(i) There is a great deal of technical skill that members of our Corresponding Societies might be prepared to put at the disposal of researchers in this

country. Many research workers have their work delayed because they do not have the skill requisite to secure the results at which they are aiming. Section making, photomicrographic work and other photographic records could be done, and that gladly, if the want were only known. It was suggested, therefore, that the Council should approach the Corresponding Societies with a view to securing their co-operation in such a scheme.

(ii) At several International Congresses in recent years it has been stated that scientific work has often been overlooked because of language difficulties. The Council is consequently asked to circularise the Corresponding Societies and suggest that those publishing research work should instruct authors to supply a digest not exceeding 200 words, and that the societies should print the digest at the head of the articles in question. These should be authors' summaries, because it has been reported that some authors have objected that their work has not been fairly represented in works that specialise in publishing critiques.

Representation.

The following Corresponding Societies were represented at the Newcastle meeting.

Association of Women Science Teachers.
Belfast Natural History and Philosophical Society.
Berwickshire Naturalists' Club.
Blackburn Philosophical and Scientific Society.
Botanical Society and Exchange Club of the British Isles.
Botanical Society of Edinburgh.
Brighton and Hove Natural History Society.
British Mycological Society.
British Optical Association.
Darlington and Teesdale Naturalists' Field Club.
Edinburgh Geological Society
Edinburgh Natural History Society.
Folk-Lore Society.
Geographical Association.
Geological Society of London.
Geologists' Association
Glasgow and Andersonian Natural History and Microscopical Society.
Hampstead Scientific Society.
Hastings Natural History Society.
Hertfordshire Natural History Society.
Le Play Society.
Liverpool Botanical Society.
Liverpool Geological Society.
Manchester Statistical Society.
Museums Association.
National Association of Head Teachers.
National Farmers' Union.
Literary and Philosophical Society of Newcastle upon Tyne.
Natural History Society of Northumberland, Durham and Newcastle upon Tyne.
Northern Naturalists' Union.
Plymouth Institution and Devon and Cornwall Natural History Society.
Quekett Microscopical Society.
Rochester and District Natural History Society.
Royal Entomological Society of London.
Royal Society of South Africa.
School Nature Study Union.
Society for the Promotion of Nature Reserves.
Sorby Natural History Society, Sheffield.
Southport Scientific Society.
Woolhope Naturalists' Field Club.
Yorkshire Geological Society.
Yorkshire Naturalists' Union.

RELATIVE DATING OF THE PILTDOWN SKULL[1]

BY

DR. KENNETH P. OAKLEY

IN a paper read before Section H in September 1947 attention was called to the analytical work on fossil bones by Carnot, which had shown that their fluorine content increases with geological age. This conclusion had generally been regarded as having no practical importance, for owing to the wide variation in the relative abundance of this element at different localities it would obviously be impossible to ascribe a geological date to a particular fossil bone merely by determining its fluorine content. However, it was suggested that as a means of differentiating bones of various ages occurring mixed together at a single site fluorine analysis might be helpful.

An investigation carried out by Dr. H. J. Walls in the Home Office S.W. Forensic Science Laboratory showed that there is nothing to be gained by using a spectrographic method to determine the rough order of magnitude of fluorine in bone samples. Recourse must be made to a chemical method of estimation. In 1948 the Department of the Government Chemist agreed to collaborate with the Department of Geology, British Museum in exploring further the possible applications of fluorine analysis of bone. Mr. R. H. Settle, Dr. C. R. Hoskins and Mr. E. C. W. Maycock in the Government Laboratory undertook the determination of fluorine in a series of small bone and tooth samples selected by the author. The results obtained have shown that this is a useful means of establishing the relative antiquity of bones at particular sites.

The application of this method to the Galley Hill Skeleton was described to a meeting of Section H in September 1948. A full report has since been published in *Bulletin of the British Museum* (*Nat. Hist.*), *Geology* I, no. 2 (1949). Briefly, it was shown that indigenous fossil bones in the Middle Pleistocene gravels at Swanscombe contain around 2 per cent. fluorine, those from Upper Pleistocene deposits in the same region around 1 per cent., and post-Pleistocene bones 0·05–0·3 per cent.; the Galley Hill Skeleton although found in Middle Pleistocene gravels proved to contain about 0·3 per cent. fluorine, and was therefore clearly an intrusive burial. The Swanscombe Skull on the other hand showed the expected 2 per cent. fluorine.

The investigation has now been extended to the famous fossil remains from Piltdown near Fletching, Sussex. The analyses in this case were carried out by Dr. C. R. Hoskins.

The Piltdown gravel has yielded fossil bones and teeth of several ages. The oldest group, which includes *Mastodon arvernensis* and *Elephas* ['*Stegodon*'] cf. *planifrons*, is of Villafranchian age, formerly classed as Pliocene but now regarded as Lower Pleistocene. The later types represented in the gravel, such as *Cervus elaphus* and *Castor fiber*, are of Middle or Upper Pleistocene age—indeed it is possible that this post-Villafranchian material represents more than one period, for the gravels have evidently been repeatedly re-arranged.

Whether the bones and teeth referred to *Eoanthropus dawsoni*, or 'Piltdown Man,' belong to the older or to the younger group has been a matter of controversy since they were first described. Dawson and Smith Woodward considered that *Eoanthropus* was approximately contemporary with the later group of animal remains, which they called 'early Pleistocene' in contradistinction to the older group which they recognised as 'Pliocene.' E. T. Newton and Sir Arthur Keith regarded *Eoanthropus* as more probably of the latter age. Similarly Dr. A. T. Hopwood after re-examining all the evidence in 1935 placed it with the Red Crag or Villafranchian group (which, however, he classed as Lower Pleistocene). Mr. A. T. Marston, who considers that the Piltdown mandible and canine tooth are anthropoid, has been inclined to refer these elements to the Lower Pleistocene (i.e. Pliocene of older authors), and the typically human cranial fragments to the Upper Pleistocene.

The fluorine content of every available bone and tooth from Piltdown has now been tested by Dr. C. R. Hoskins in the Government Laboratory. All those of undoubted Lower Pleistocene (Villafranchian) age proved to contain 2–3 per cent. fluorine, while all those which are certainly of later date showed less than 1·6 per cent. fluorine. The *Eoanthropus* material, including all the cranial fragments, the mandible, the isolated canine tooth, and the remains of the second

[1] Substance of a paper read to the Section of Anthropology and Archaeology, at Newcastle, on September 5, 1949. A fuller account of this work will be sent to *Nature* early in 1950.

skull found 2 miles away, showed extremely little fluorine (average 0·2 per cent.).

It is evident that fluorine has been deficient in the environment since the Piltdown gravels were accumulated, but the fluorine test has shown conclusively that all the specimens referred to *Eoanthropus* are contemporary, and that their age is not Lower Pleistocene, but considerably later. In fact, they evidently belong to a period immediately preceeding the final re-arrangement of the deposit. From the palaeontological data alone it is not possible to decide whether this took place during Middle or Upper Pleistocene times.

Clement Reid pointed out that the gravels appeared to rest on a low plateau surface (100–120 ft. above O.D.) which was extensively developed in the Weald, but which was nowhere covered by marine deposits of the period of the submergence represented by the Goodwood raised beach (135 ft. above O.D.). It therefore seems unlikely that this surface existed before the phase of base levelling which followed the great interglacial period. Viewed as a terrace deposit of the River Ouse, the Piltdown gravel would have to be classed as belonging to the Taplow group (Edmunds 1926). From the temperate character of even the latest faunal elements in the Piltdown faunal mélange, it is probable that *Eoanthropus* lived under interglacial conditions, although the final re-sorting of the gravels may have been brought about by solifluxion. Provisionally *Eoanthropus* may be referred to the last interglacial period (Riss-Würm).

The results of the fluorine test have considerably increased the probability that the mandible and cranium represent a single creature. The relatively late date indicated by the summary of evidence suggests moreover that ' Piltdown Man,' far from being an early primitive type, may have been a late specialised hominid which evolved in comparative isolation. In this case the peculiarities of the mandible and the excessive thickness of the cranium might well be interpreted as secondary or gerontic developments.

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SUMMARY OF A NOTE ON THE PILTDOWN SKULLS[1]

RECEIVED FROM

DR. ROBERT BROOM, F.R.S.

During his visit to England in the Spring of 1949 the author took the opportunity of re-examining the remains of the two skulls attributed to Piltdown Man (*Eoanthropus*). He found that the British Museum also possesses parts of a third fossil human skull found by Charles Dawson in Pleistocene gravel at Barcombe Mills near Piltdown. This has not yet been described, but would probably be worth detailed comparison with the two previously known Piltdown skulls and the Swanscombe skull. The material comprises a large frontal bone (intertemporal measurement 102 mm., interorbital width 28·5 mm.), two malar bones and a slightly worn molar. This tooth (probably M_3) shows two marked outer cusps, and two inner, but no distinctly developed 5th cusp. This tooth is not at all anthropoid, nor is it quite typical of modern man.

The author now has scarcely any doubt that the Piltdown mandible belongs to the same individual as the associated brain-case. He considers that *Eoanthropus* was a big-brained type of man which evolved on a quite different line from true *Homo*. The ' simian shelf ' in the lower jaw is probably not an indication of close affinity with the anthropoids, but a specialisation due to evolution parallel with that of the modern apes, just as the large brain of this type of man may have been a parallel development to what is found in the *Homo* line.

[1] Read by Dr. K. P. Oakley to the Section of Anthropology and Archaeology, at Newcastle, on September 5, 1949.

MICROBIAL DIGESTION IN THE ALIMENTARY TRACT[1]

BY

DR. D. P. CUTHBERTSON AND OTHERS

THE rôle of the microbial populations of the alimentary tract is one that has fascinated not only physiologists, biochemists and microbiologists, but also medical men and agriculturists. It is a field of common interest, for it is concerned not only with the nature of the processes by which grass and other fodders are turned into meat, milk, fat, wool and hide, but it explains why ruminants such as cattle, sheep and goats are the world's most important producers of these elemental needs. This study raises many problems in connection with the rôle of the bacterial flora of the large intestine in the nutrition of man himself, and helps to describe the nature of the disturbance in diseases such as sprue and pernicious anaemia.

A STUDY of the anatomy and physiology of the alimentary tract of mammals permits certain generalisations to be drawn. In brief they are as follows :

(i) In animals which are wholly or primarily carnivorous there is no very special development of the alimentary tract for microbial digestion as there is no real need for much biosynthetic activity. The flesh and viscera of the prey conform generally in amino-acid pattern to that of the carnivore itself and the task of transmutation would generally appear to be most easy in these circumstances.

(ii) In most omnivores fermentation on any large scale does not take place in the large intestine but the caecum and colon have the size and provide the environment necessary for bacterial growth on food residues. Such microbial activities would appear to assist the organism to withstand a reduction in the intake of certain vitamins, particularly those of the B-group, below what would appear to be normal requirement level. Only products produced outside the cell or made soluble by the break up of dead cells seem to be potentially available to the host. The presumptive evidence is that some of these are absorbed directly or obtained by coprophagy.

(iii) Although all herbivores initially start life by drinking their mother's milk their digestive tracts subsequently develop so that they can deal with grass and coarse fodders. This is particularly marked in the ruminant.

Dr. E. I. McDougall has found that, during the first few hours or so after birth, it is possible for antibody protein of the colostrum of the ewe to be absorbed from the digestive tract of the sucking lamb. This protein appears as part of the relatively marked proteinuria which occurs during the first day or two after birth (McCarthy and McDougall, 1949). This phenomenon occurs before there is any appreciable development of a rumen.

In the ruminants we find that the stomach is modified so that there are four compartments of which the first two, the rumen and reticulum, together form a large fermentation vat where coarse fodder material which would otherwise resist the enzymes secreted by glands of the alimentary tract (which contain no cellulase) is digested by enzymes produced especially by the rumen bacterial population and new compounds such as microbial protein and starch are found which later become available to the animal by the normal digestive processes of the abomasum (true stomach) and upper parts of small intestine.

The rôle of the protozoa is not yet fully understood but undoubtedly protein and starch are found within them. On the whole, the evidence is against these organisms playing an important rôle.

In addition to the microbial protein and polysaccharide formed, other compounds such as the short-chain fatty acids, acetic, propionic and butyric, and ammonia are formed and are absorbed through the stratified squamous epithelium of the wall of the rumen.

The recent work of Marston and Lee (1949) in Australia and of Becker, Smith and Looslo (1949) in the United States has shown that pining in sheep due to cobalt deficiency in the pasture is not susceptible to vitamin B_{12} which itself contains cobalt, either when given by vein or by mouth, at least in the

[1] Report of a joint discussion by the Sections of Physiology and Agriculture on September 6, 1949, during the Newcastle Meeting of the Association. Edited by Dr. D. P. Cuthbertson (Rowett Research Institute, Aberdeen) who opened the session.

amounts given which should have been sufficient to offset any vitamin B_{12} deficiency.

A pilot experiment carried out by Mr. W. Thomson has demonstrated that the size of the fodder fragments has a demonstrable effect on the size of the rumen in the sheep. The finer and more concentrated the diet, the smaller the rumen.

(iv) In the equidae there is no special development of the stomach but the main seat of microbial activity is in the large intestine which is specially developed for the purpose. This permits the horse to live on coarse fodder provided it has time to eat enough.

(v) So far all mammals examined have a microbial population in the large intestine so that this form of biosynthetic activity is general and normal.

The papers which follow describe in more detail certain aspects of this most fertile field for discovery.

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General Consideration of Conditions

by

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Short chain fatty acids are present in those parts of the alimentary tract in which fermentation occurs. The concentration found in the rumen and in the large intestine of other species are of the same order, and the mixture of acids consists principally of acetic, propionic and butyric. In order that fermentation can proceed the acid products must be removed or neutralised. In the sheep the saliva contains bicarbonate and in twenty-four hours sufficient is secreted to neutralise from one-half to two-thirds of the acids present in the rumen of animals taken from pasture. As fermentation is continuous it is clear that saliva alone is not sufficient to maintain a *p*H between 6 and 7. The amount of fatty acid passing to the abomasum is less than 1 g. per hour. The principal means whereby the *p*H is maintained close to neutrality is by the passage of ions from the rumen to the blood. This is shown by the fact that acid or alkaline solutions, when introduced into the empty rumen from which the entrance and exit are closed, rapidly move towards a *p*H of approximately 7·4. In addition, it is known that fatty acids in both free and ionised states are absorbed from the rumen into the blood stream. When cellulose is fermented by rumen organisms *in vitro* more propionic acid is formed than acetic. In the rumen, however, far more acetic is present than propionic. This had led to the suggestion that propionic is preferentially absorbed. This is true as far as the free acid is concerned : it is not true concerning the ionised acid and at a *p*H of between 6 and 7 the proportion of ionised acid is far greater than free acid. When dried grass is fermented by rumen organisms *in vitro* the proportion of acetic to propionic is nearer the proportions found in the rumen than with cellulose alone. It is probable that preponderance of acetic is due partly to the presence of pentosans and other fermentable substrates in natural fodders.

The gas which is present in the rumen consists of methane, carbon dioxide, oxygen, and sometimes hydrogen sulphide. The proportion of oxygen is usually less than 2 per cent. and on this account the conditions can be described as anaerobic. This is an important factor in limiting the kinds of the organisms that are active in the rumen. Fluid collects in the anterior part of the reticulo-rumen sac and owing to the brisk contractions of the reticulum which occur approximately once a minute the food in the rumen is continually flushed with the fluid material from the reticulum. The strong contractions of the rumen keep the food contained within it in motion. The passage of food from the reticulum to the omasum is continuous and the volume of material passing from the abomasum is not less than 300/450 ml. per hour. The passage of any food from the rumen is extended over a period of days for it becomes mixed with food residues of previous meals. Stained particles of food have been found to persist in the rumen of cows up to seven days after administration. The passage of food through the alimentary tract of the ruminant is slower than it is through the horse and the pig and this is one reason why less cellulose is digested in animals in which fermentation is confined to the large intestine. With sheep, fibre isolated from the faeces contains cellulose that is still fermentable if this material is resuspended in the rumen. Time appears to be a factor limiting the amount of cellulose fermentation that can occur in the alimentary tract when partially lignified fibres are given.

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Food structure and microbial interrelations

by

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Direct microscopy has been employed to compare the relative importance of microbial agents and digestive secretions in the breakdown of raw maize and raw potato starches during passage through the digestive tract of mice, rats, guinea-pigs, hamsters, rabbits, domestic pigs, sheep, oxen and men.

Sites of digestion, microbial agents and structural factors are of great importance in determining the nutritional outcome of starch digestion.

Sites of digestion

(i) In domestic pigs, rabbits, guinea-pigs, rats and mice :—

(*a*) Maize starch was broken down by digestive secretions in the small gut.
(*b*) Potato starch was broken down by micro-organisms in the caecum.

(ii) In sheep and oxen maize was completely, and potato starch incompletely, broken down by micro-organisms after sixteen hours in the rumen.

(iii) In the hamster microbial breakdown of potato starch occurred in both the cardiac diverticulum of the stomach and the caecum.

Microbial facies

The microbial agents directly associated with the breakdown of the starch formed a number of distinctive microbial facies which included :—

(a) In rats, mice, rabbits, and hamsters a coccoid facies.
(b) In guinea-pigs a facies of curved rods.
(c) In domestic pigs giant Clostridia.
(d) In sheep and oxen a facies of giant sarcinae and streptococcus type.

Microbial breakdown in all cases was uniformly accompanied by polysaccharide synthesis and a rise in density of gram positive microflora.

Structural factors

Structural factors influence the mode of breakdown and dietary value of potato starch for rats fed a vitamin B deficient diet. Unground starch was associated with refection. But, if the starch was ground to 31–98 per cent. solubility in cold water most of it was digested in the small gut and rats showed symptoms of avitaminosis.

The organism chiefly responsible for the breakdown of structural starch in the pig's caecum has been isolated and typed as *Clostridium butyricum*. This organism is capable of producing an amylase in cell-free filtrates when grown in a starch medium. A detailed study of the action of the enzyme on tuber, cereal, processed starches, and starch products has been carried out. The kinetics of the enzyme have been investigated for us by Dr. W. J. Whelan at Bangor University.

Cl. butyricum is also capable of synthesising riboflavin, nicotinic acid, pantothenic acid, pyridoxine and folic acid in significant amounts.

It is evident that on feeding cooked potatoes to pigs, maximum utilisation of carbohydrate will be secured. But on feeding the potatoes raw, products of microbial synthesis and breakdown will in principle be available to the animal. An experiment at the Rowett Institute is in progress to assess the nutritional consequence of feeding pigs raw potatoes versus cooked potatoes.

A second experiment at the Rowett Institute to determine whether the vitamins synthesised by microbial action are available to the host is in progress. Three groups of pigs were fed on a vitamin B deficient diet, with the following carbohydrates : maize, potato and boiled potato starches, and a fourth group on an adequate mixed diet as a control. Pigs on maize-starch B-deficient diet reached a critical condition and those on boiled potato died after four weeks. In contrast, pigs on raw potato-B-deficient diet have remained in good health for over nine weeks. The amounts of vitamin B synthesised and the extent to which they are utilised by the host is being investigated by microbiological assay.

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The nature of dietary protein in relation to its utilisation by the ruminant

by

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The activities of the microbes in the rumen may lead, depending on the dietary conditions, to either a net gain or loss of nitrogen to the host animal. Since the primary function of the rumen is the digestion of cellulose, the supply of nitrogen for the growth and metabolism of the cellulose-splitting organisms represents an essential requirement for ruminal activity. The qualitative nitrogen requirements of these organisms have not been determined. When suitable sources of energy are

provided, the microbes of the rumen are able to utilise nitrogenous substances, other than amino-acids, for their growth, and the subsequent digestion of the microbes yields protein to the host: (McNaught and Smith, 1947): the precise conditions required for the maximum utilisation of such substances, e.g. urea, have not been ascertained. Ammonia appears to occupy a key position in the nitrogen metabolism of the rumen ; it is probably the chief source of nitrogen, apart from amino-acids, used by bacteria for growth in the rumen ; it is formed by the hydrolysis of urea (in saliva and feedstuffs, and by the deamination of proteins, and usually comprises the major part of the non-protein-nitrogen in the rumen fluid (McDonald, 1948). Ammonia is absorbed from the rumen into the portal blood stream (McDonald, 1948) and converted by the liver into urea ; thus some part of the ammonia in the rumen may enter a nitrogen cycle via the liver and salivary glands and part will be lost to the animal by excretion as urea in the urine. Loss of ammonia-nitrogen in this way probably constitutes an important factor limiting the usefulness of urea as a feeding stuff for ruminants. When feed protein is used as the source of nitrogen for microbial growth, a new assemblage of amino-acids, characteristic for each species or organism, is presented to the host animal for subsequent digestion ; this tends to enhance or reduce the biological value of the digested protein, depending on the relative values of the microbial protein and the feed protein (Johnson, Hamilton, Mitchell and Robinson, 1942) and the proportion of the feed protein converted by the micro-organisms into the proteins of their own body structures (McDonald, 1948). In the course of their growth, the micro-organisms will synthesise not only proteins but also a variety of other nitrogenous substances (especially nucleic acids) which probably represent waste products for the host animal. Analysis of rumen microbes has shown that not less than 10 per cent. of their total nitrogen occurs as nucleic acid (McDonald, 1949). Some of the chief aspects for further study of the digestion of protein by ruminants are : (i) The extent of degradation of proteins in the rumen to nitrogenous substances which are not available to the host, and the extent to which these, and similar substances in the food, can be used by the microbes for their growth. (ii) The influence of non-nitrogenous substances, e.g. carbohydrates, on the growth of microbes in the rumen. (iii) The relative proportions of protein-N and non-protein-N, especially nucleic acid, in the bodies of the microbes. (iv) The distribution of amino-acids in the microbial proteins. (v) The digestibility of the proteins of the microbes. (vi) The relative proportions of unchanged food protein and microbial protein in the digesta received by the true stomach (the abomasum). The available information on each of these topics is as yet too fragmentary to enable a satisfactory picture of protein digestion to be drawn.

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Vitamin synthesis in relation to requirements

by

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Microbial synthesis of vitamins of the B complex and of vitamin K has been shown to take place in the intestinal tract of most avian and mammalian species. (Mitchell and Isbell 1942 ; Peterson and Peterson, 1945).

In ruminants synthesis occurs also in the rumen, before the food enters the true digestive and absorptive tracts, so that specially favourable conditions exist for the utilisation of the products. The evidence for such synthesis is mainly derived from studies with animals having a permanent opening or fistula into the rumen. In these studies synthetic or natural diets were fed ; then, after a few hours samples of rumen material were removed through the fistula, and their vitamen content compared with that of the food. The results indicated that the rumen contents were, on a dry weight basis, substantially richer than the diet in almost all the vitamins of the B complex measured. It is considered that microbial synthesis supplies the adult ruminant with all or most of its requirement of these vitamins (Goss, 1942–43; Kon and Porter, 1947–48). The young ruminant, however, is without this active microbial flora for the first few weeks of life, and is, therefore, just as dependent on an exogenous supply of vitamins as the dog or the rat (Savage and McCoy, 1942 ; Wiese, Johnson, Mitchell and Nevens, 1947a ; Wiese, Johnson, Mitchell and Nevens, 1947b ; Wiese, Johnson and Nevens, 1946).

In non-ruminants the main site of microbial activity is the large intestine and, although much microbial synthesis undoubtedly occurs, the amount of vitamins available to the host is limited, possibly by the nature

of the epithelium lining this part of the gut, which does not appear to be adapted for the absorption of nutrients, and certainly by the fact that the synthesised material is within the microbial cells, which are not, as in the ruminant, broken down by digestive processes, but are largely excreted intact. Nevertheless, evidence has accumulated to show that the non-ruminant does derive some benefit from microbial vitamin synthesis. Thus, administration of sulphonamide drugs, which, through their bacteriostatic action, interfere with the intestinal micro-organisms, reduces the synthetic output of some of the vitamins and can, under certain conditions, produce symptoms of vitamin deficiencies (Kon, 1945).

Recent work has shown that this symbiotic vitamin synthesis may also play a part in the vitamin economy of man (Denks, Grundy, Wheeler, Henderson and Berryman, 1946). Several series of experiments were done by American investigators in which groups of healthy adults received diets containing subnormal amounts of one or more vitamins of the B complex. Urine and faeces were collected and analysed for their vitamin content. Thus the input and output of various vitamins could be compared. The average faecal excretion of all the vitamins studied was as high on the restricted as on the normal diet, but the average urinary output was lower on the restricted diet. Thus appreciable vitamin synthesis was taking place, but the lowered urinary excretion emphasises that the value of such synthesis to the host is limited by the poor intestinal absorption of the products.

An interesting condition, that of refection, can arise when certain non-ruminants receive a diet rich in raw starch (Fridericia, 1926 ; Fridericia, Freudenthal, Gudjonsson, Johansen and Schonbye, 1927–28 ; Kon, 1945). In this condition, animals normally dependent on a supply of vitamins in the food can dispense with it entirely. The occurrence of refection in the rat is dependent on the presence of raw starch and of starch splitting organisms in the caecum. The end-products of fermentation lower the *p*H, and this appears to promote the growth of the micro-organisms, to favour intestinal synthesis, and to increase absorption. The animal in fact becomes a vicarious ruminant, the caecum combining some of the functions of the rumen and of the true stomach.

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Integration of microbial activities from the biochemical standpoint

by

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In this paper a summary was given (Table I) of the known reaction products in rumen contents, which mostly occur as the result of the activities of the micro-organisms that inhabit the rumen of sheep (for a recent review see Elsden and Phillipson, 1948). In addition some figures were given of the work carried out at the Rowett Research Institute during 1947–49, showing the concentration of certain of the constituents of the rumen contents (e.g. volatile fatty acids, NH_3–N, NPN–N, fermentable and non-fermentable reducing substances, the microbial matter etc.) during a digestion cycle in sheep maintained on hay. These figures were compared with the available figures for similar constituents in sheep saliva (McDougall, 1948) and in hay on which the sheep were maintained. The volatile fatty acids, the mineral constituents and the microbial matter, with some fine plant residues, contributed almost the whole of the dry matter of the rumen liquid. The concentration of total reducing substances, throughout a digestion cycle was about 1·8 to 3·5 per cent. ; well below 10 per cent. of the known concentrations of similar substances in the blood stream of the sheep. On the other hand the concentration of NH_3–N in the rumen liquid varied between about 7 to 16 mg. per cent. as compared with the recent figure (McDonald, 1948) of 1·5 mg. per cent. in venous blood draining the rumen of the sheep. Although the concentration of soluble carbohydrates and nitrogenous constituents in the rumen contents is relatively low, when compared with the concentration of similar constituents in artificial media used in the cultivation of pure cultures of micro-organisms, the density of rumen micro-organisms nevertheless reaches a figure of over 1 per cent. microbial dry matter per

100 ml. rumen contents. This figure is high when compared with Thaysen's finding (1945) that strained rumen liquid of the ox contained 400 mg. microbial dry matter per 100 ml. It is likely that the latter figure is on the low side as it is known from direct counting experiments of Gall *et al.* (1947) that ' rumen solids ' were richer in bacteria than the ' rumen liquid.'

In discussing the anabolic cycle of rumen micro-organisms, mention was made of the recent work on the relation between the dietary cobalt and the cobalt situated in rumen micro-organisms, as it was demonstrated (Tosic, and Mitchell, 1948) that: (a) micro-organisms of the rumen accumulate cobalt from their external environment; (b) the concentration of cobalt in the microbial population of the rumen is related to the concentration of cobalt in the diet; and (c) a large proportion of cobalt present in the rumen contents is situated in the micro-organisms, the concentration in the external environment being very low, particularly in sheep fed diets low in cobalt. Further figures were given of the extended work on other ' trace elements ' which are also concentrated by micro-organisms of the rumen (Mitchell and Tosic, 1949). The accumulation of certain ' trace elements ' in micro-organisms of the rumen and some organs of the host, and their distribution between micro-organisms of the alimentary canal and their external environment may assume, it was suggested, some importance in aetiology of diseases due to a deficiency of certain ' trace elements.'

TABLE I

THE RUMEN CONTENTS

GAS PHASE	LIQUID PHASE	SUSPENDED MATERIAL
CO_2	Reducing substances	Rumen bacteria
CH_4	Fermentable	
	Non-fermentable	Rumen protozoa
N_2	NH_3-nitrogen	Yeast-like organisms
O_2	NPN—(NH_3–N)	
		Plant residues
(H_2)	Mineral constituents	
(H_2S)	Volatile fatty acids	
	Acetic	
	Propionic	
	Butyric	
	Unidentified	
	Lactic acid	
	Pyruvic acid	
	Vitamins, etc.	

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TECHNOLOGY AND THE HUMANITIES IN FURTHER EDUCATION[1]

BY

PROFESSOR AUBREY F. BURSTALL

THE courses of instruction given to engineering undergraduates in Britain are devoted mainly to Physics, Chemistry and Mathematics, and to the technology involved in applying them to engineering problems. At the University of Durham the courses in Applied Science have recently been modified, and, for the pass degree in Mechanical Engineering candidates are now required in their final year to take a course of instruction and to achieve a prescribed standard in four principal (Group I) subjects and two subsidiary (Group II) subjects all of which, with one exception, could be described as technological or engineering subjects, requiring skill and understanding in the application of Mathematics to engineering problems.

The innovation is a principal (Group I) subject which has been called ' Engineering Administration.' The instruction given in this subject at King's College, Newcastle consists of three parts, (i) a course of 26 lectures on Factory Organisation and Management, (ii) a course of 26 lectures by the Professors of Economics, Accounting, Psychology, Industrial Health, and by an Industrialist in what might be termed Applied Philosophy, (iii) a course of general reading and technical report writing.

Much of the subject matter introduced with Engineering Administration may be regarded as an introduction of the humanities into the further education of the engineer. All that we hope to do in the time available is to give the students an appetite for more. Here, for the first time in his engineering course, the perceptive student is likely to discover that the character and personality of his teacher is more important to him than the quantity or elegance of presentation of the subject matter that is taught. As he struggles to improve the grammar of his sentences, the better to express himself, he may learn something of the artist's joy in his own creation, and perceive how much he might broaden his own education after he has left the university.

[1] Paper read by A. F. Burstall, Professor of Mechanical and Marine Engineering, King's College, Newcastle, to the Education Section of the British Association on September 2, 1949.

For this group of subjects the brilliant young lecturer, so invaluable in teaching the mathematical solution of engineering problems, will not suffice. One requires men with experience of life and of industry ; men who have held administrative posts where they have had to exercise their judgement and made mistakes ; probably men who have read widely and thought deeply ; men who have found a philosophy of life and yet are willing to lay bare their souls before their students. Those who have so willingly cooperated with me in giving these courses would not claim these virtues but they are all people who have some of them. Moreover, they were all intensely interested in this new course, as they were in their own subject, in the message they had to give to the students, and in the students themselves.

The interest of the students and their enthusiasm for Engineering Administration surprised me. No one objected to the report writing though mistakes had to be corrected, and the reports had to be re-written and submitted again. Several realised before the year was out that those who were best at Engineering Administration were not always the same as those who were best in the other engineering subjects. The correctness of this surmise was proved after the examination when the marks were analysed, for whereas the marks in the technical subjects showed a reasonable correlation, as from one technical subject to another, it was found that there was no correlation whatever between the marks in Engineering Administration and those in the other subjects. Some students who had high marks in their technical subjects were weak in Engineering Administration, with some the reverse was the case ; some did well in all subjects and a few were uniformly weak in all subjects.

It seems then that this kind of subject is a test of some other quality of mind that is not tested by examining in technical and scientific subjects. Perhaps the most obvious quality that is tested in this way is the ability to express oneself in qualitative terms about intangible questions which cannot be expressed in precise or mathematical language. If these are qualities that a technologist ought to have

developed at college, then we are performing a useful service in giving such instruction and testing the candidates' understanding of it by examination.

The time devoted to the humanities (if the subject matter of Engineering Administration can be so described) is still a very small proportion of the total time that the student spends in studying for his degree. It amounts to less than one-sixth of the study time in the final year, and no time at all is given to it in any other year of the course. Students who reach their final year do so by passing tests and examinations in technical and scientific subjects only, and there is no place in an engineering department in a university to-day for a man who has not acquired the technique of using Mathematics in the solution of technical problems. I think this is to be deplored. Combined with the growing insistence upon the possession of a university degree for so many posts in Government and industry and the ever-rising mathematical standard in our engineering courses, it will result ultimately in all our engineering work being dominated by mathematical minds. I fear that this may not be a good thing. There may be men of character and of value to the engineering profession who cannot stomach the mathematical discipline. They may be fascinated by engineering work and determined to succeed at it, some having the creative type of mind that is often undisciplined, others administrative ability amounting almost to genius. Are these men to be deprived of a university education?

If they are not to take an engineering course at the university how else shall they prepare themselves to enter the engineering profession? It has been suggested that such men should read for a degree in Commerce, Economics or Accountancy, and then seek admission to the engineering world on the commercial side, but this course does not appeal to the young student who is interested in engineering but not in Mathematics.

The time is probably overdue when some alternative courses in engineering should be offered for those who cannot achieve the standard in mathematical discipline now required in engineering courses at the universities. The question is what other discipline can be substituted for the mathematical one without lowering the standard? My own preferences are for Logic, Economics and Psychology, or for a training in creative work such as design or construction. Possibly all these could be combined with some engineering studies but almost inevitably the length of time required to achieve a reasonable standard would be longer than is needed for a training in the mathematical technique.

A university course that includes Design presents some special difficulty from the teaching point of view. If it is to be well done the teachers should be practising designers and nowadays that implies that they are not teachers. A sandwich system for the student between university and industry would appear to be one way out of this difficulty. Exchange of staff would be another. Both of these solutions are fraught with practical difficulties at the present time.

A course in the alternative subjects—Logic, Economics and Psychology—is more practicable, though even here it is difficult to find teachers who are prepared to devote themselves to sidelines to the main study of those three subjects. Engineering students learn most easily from teachers who are qualified engineers, and it is only the exceptionally enthusiastic or gifted teacher of some other subject who can gain and hold the interest of a class of engineering students in studies which may seem to them academic or unreal. So far we have experimented only to the extent of 5 or 10 lectures on each subject and so the studies have been comparatively superficial. How successful we should be if the studies were deeper and more prolonged remains to be discovered.

When Engineering Administration was introduced into the engineering course at Durham University voices were raised in protest against the teaching of report writing on the ground that this should have been learnt at school. Similar objections were made at the University of Melbourne some years ago when I was responsible for introducing cultural or non-technical subjects into the engineering course there. The subjects there were Logic, Economics, Jurisprudence, Public Health, Industrial Psychology, Land Utilization in Australia, and World History. Courses of lectures of this kind given by the Professors in their subject can be a source of inspiration and understanding to the technical student and are of a totally different character from anything he may have learnt at school. Moreover, the student in his final year is beginning to know something of life from his experiences at home, at the university and in his vacation work in industry. One can see that understanding has begun to awaken in his mind by the enthusiasm with which he discusses philosophical and political questions whenever they are mentioned.

The wide extension of university scholarships, bursaries and grants, has resulted in the admission of engineering students who are more uneducated, in the broad sense, than heretofore. Some of them have never been to a good school and have learned their Mathematics, Science and a modicum of English at evening classes while working in

industry during the day time. In spite of these disabilities the students who have come up to the university in this way—with Higher National Certificates in Engineering—have achieved marks in Engineering Administration equal to those of other students. The Higher National Certificate students have also done just as well as the other students in all the other subjects of their course, and this year the highest marks in the Final Pass Examination were obtained by one of them.

The greatest difficulty that the Higher National Certificate candidates present to us at the present time is how to select the best of those who apply for the small number of places that we have available. So far I have relied mainly on the result of a personal interview with each candidate but I am very conscious of my own shortcomings as an interviewer and I should like to supplement the interview with some more impersonal test. Should it be an intelligence test, or a written examination? If the latter, what should be the subjects?—Mathematics, Mechanics and English presumably for engineers. However, one hesitates to restrict the admission of these candidates to those who are most successful in a competitive entrance examination.

A young man training to be an engineer has other courses open to him besides reading for a university degree. Most of the professional institutions now hold their own examinations and award qualifications for which the student can prepare himself by attending full-time or part-time courses at a technical college. It is therefore worthwhile to ask why the university degree is so often preferred both by student and employer as the technical qualification to be sought.

The most cogent answer I have had to this question from employers is that they like to have some of their staff chosen from men who have mixed while at college with students of other faculties so that they have acquired a balanced outlook upon life and can understand the points of view of people engaged in other professions. The opportunities for mixing with other students are provided in the students union but they are much greater for the fortunate few who secure places in the residential colleges. That is the best milieu in which technology and the humanities can come together for the further education of the individual.

During the informal debates and discussions that take place in a residential college, not only does the technologist learn something about the humanities but the classical scholar, the lawyer and the musician also learn something about technology. It surprises me that my colleagues in the Faculty of Arts are so backward in asking for courses for their students about the aims and purposes of Pure and Applied Science in the modern world. An attempt on these lines was begun at the University of Melbourne in 1945 when a decision was made to appoint a lecturer in Scientific Method to be attached to the Faculty of Arts.

I conclude by referring to the most intractable problem I know in which technology and the humanities are both concerned at the university. Should the universities offer special courses of training for management and, if so, what subjects or groups of subjects should be included in them? Those who advocate making management a closed profession like the medical profession wish to see university degrees in management made a compulsory requirement for anyone holding a managerial position.

The universities in this country have not responded enthusiastically to the suggestion that they should provide degree courses in management. Some have established chairs of Industrial Relations and Business Administration, and the Department of Industrial Administration at the Manchester College of Technology has earned a well-deserved reputation in what may be termed the clinical teaching of a Management Faculty. But little or no provision seems to have been made at the universities for those who intend to make management studies their post graduate work. How should they prepare themselves for this task? By first taking a degree course in Philosophy, Classics, Economics, Law, History or Engineering? Each of these has been seriously suggested to me at different times. Surely one could devise some combination of these that would give a man a more balanced view than any one of them alone. My own choice would be for a combination of four main studies extending over four years.

(i) Philosophy—Logic and Ethics.
(ii) Economics—including the principles of Accounting.
(iii) The principles of Physical Science—mostly Applied Science including Machine Drawing and some laboratory work—taught with the minimum of Mathematics.
(iv) Biological Science—Human Physiology and Psychology. Emphasis on Public Health, Safety and Industrial Psychology.

If the study of these subjects were continued for four years at the university it could hardly be described as superficial and it ought to make the successful candidate worthy of a bachelor's degree.

This is the best solution that I can offer for bringing together Technology and the Humanities in Further Education.

RADIO ASTRONOMY

At the Newcastle Meeting of the Association, the Physics Section arranged a session on Radio astronomy at which three papers were given. The speakers dealt with the use of radio techniques for studying astronomical phenomena at three, very different, distances from the earth ; investigating meteors in the upper atmosphere, observing the behaviour of the sun and locating sources of galactic radiation. The substance of the three contributions is given below.

New Developments in Meteor Astronomy

by

Dr. A. C. B. Lovell

Meteors, or shooting stars, are small pieces of debris which rush into the earth's atmosphere at great speed and burn away at heights of about 60 miles. This gives rise to the brilliant short-lived streaks of light which are sometimes seen in the night sky. Until recently, naked eye observation of these meteor streaks was the only method available to astronomers for studying this phenomenon, and only limited progress could be made because of the hindrance caused by cloud and moonlight and the impossibility of knowing what was happening in daylight. It is now possible to study these phenomena without being able to see the sky, because when a meteor burns away in the high atmosphere it leaves behind a dense trail of electrons which give a transient radio echo on a suitable apparatus. These echoes are similar in appearance to the ordinary radar echo from an aircraft seen on a cathode ray tube, but are generally very short lived.

The development of such techniques has removed the major obstacle to the rapid progress of meteor astronomy since the meteoric activity can be surveyed by day and night under any weather conditions. One of the first fruits of this new development was the discovery of great meteor activity in the summer day-time. The visual workers were aware that on about a dozen occasions throughout the year the earth passes through areas of meteoric debris of considerable extent, giving rise to the phenomena of meteor showers generally lasting for a few nights. The Perseids in August and the Geminids in December are good examples, giving rise to some 50 meteors per hour which can be seen by the naked eye. But the radio observations have shown that the displays during the summer day-time are far greater in extent than any night-time showers. At the beginning of May the earth enters an area of meteoric debris of vast extent. A great succession of meteor showers occurs during the sunlit hours, providing a rich celestial display until the end of August, visible only to the radio-astronomer.

The central problem before meteor astronomy is to find out whence these enormous streams of debris in space come. It is almost certain that most of them move in orbits around the sun and that a few are associated with comets. But few consider that all the meteor streams are associated with comets, and one of the major disputes is whether the debris is even localised to the solar system or whether some of it exists in interstellar space. The new ability to make a really systematic survey of these phenomena should soon enable some of these points to be settled. The precise measurement of the speed with which the meteor is travelling is both vital and difficult. Vital because a difference of less than 1 per cent. in the velocity would imply the difference between a meteor belonging to the solar system and one from interstellar space, and difficult because the speeds involved are about 100,000 miles per hour. Until recently, except for occasional bright meteors which could be photographed, velocity measurements could not be made satisfactorily, but ingenious radio methods now enable this to be done.

Quite apart from the purely astronomical interest in this new work, the meteor trails are formed in a very important region of the earth's atmosphere, the E region of the ionosphere. The dense electron trails behave in a very complex manner after the meteor has burnt away and the study of the behaviour of these trails by observation of the radio echo is of fascinating and vital interest to the physics of the high atmosphere.

Radio-Frequency Observations of the Sun

by

J. S. Hey

This paper gives some results from the observations of solar radio emissions at wavelengths of a few metres obtained during the last few

years at the Army Operational Research Group, which first became concerned with this phenomena when intense radio noise from the sun in February 1942 caused severe interference on army radar equipments.

Two types of solar radio noise have been distinguished, namely emission from sunspots and from solar flares. Only a proportion of the sunspots produce appreciable emission, the largest spots tending to be the most likely to produce high intensities. The sunspot radiation is fairly sharply beamed and comes to a peak value when the sunspot is near the central meridian on the sun's disk.

The radio emission associated with solar flares consists of sudden increases or bursts which occur at about the same time as the flares. The relationship between the flares and the radio bursts is very complex, but the bigger flares are the more likely to produce radio bursts. The bursts do not appear to show the beaming effect found in the radiation from sunspots. Although the chances of a burst when there is a flare are more evenly distributed with respect to the position of the flare on the sun's disk, the chances seem to be greater on the east side of the sun's disk than on the west.

Flares are normally observed visually as sudden brightenings of red hydrogen light occurring in the vicinity of sunspots. The flares also tend to produce enhancements of ionisation in the D-layer of the earth's ionosphere, and this is presumed to be caused by ultra-violet radiation from the flare which is absorbed in the lower ionosphere and thus cannot be observed at the earth's surface. A study is being made to find how the radio bursts are related not only to the visually observed flares but also to the effects on the earth's D-layer which can be observed indirectly in various ways, the best known perhaps being the fade-out of long-distance radio-communication links. As compared with the other flare phenomena the radio bursts are particularly characterised by the suddenness with which the intensity increases, which in the case of very large bursts may be by more than a thousand times in less than a minute.

Another aspect of the solar radio emission which is being studied at the Army Operational Research Group is its spectral distribution. It is known that the intense forms of the radiation indicate that the peak power observable at the earth occurs at wavelengths of a few metres. But there are many variations and the spectrum is known to cover a wide band of radio wavelengths. In order to investigate in more detail the spectrum of the radiation a sensitive panoramic receiver has been constructed which tunes over the wavelength band from 3 to 6 metres every second when appreciable radio emission occurs. Observations of the spectrum should help to solve the problem of how the solar radio noise is caused.

Stellar Radio Astronomy

by

F. G. Smith

The work described is a continuation of the work done in Cambridge on radio-frequency radiations from outside the earth. Various experiments on solar radiation have been proceeding for some time, and recently attention has been turned to the background of radiation from the rest of the galaxy.

The relation of radio astronomy to visual astronomy should first be outlined. Astronomy depends almost entirely on information received in the form of electromagnetic radiations. Measuring technique exists for a very wide range of frequencies of this radiation, but only limited frequency bands are of use to us as the earth's atmosphere acts as a barrier to others. One band is in the visual and near-visual range, covering four octaves at most and the other is in the radio range from 1 cm. to 20 metres, covering ten octaves.

The important difference is that the radio wavelength radiations are emitted, absorbed, reflected and refracted by low density ionised gas which has little or no visual effects. In particular the envelopes of stars, for example the corona of the sun, may be cited. A telescope working on these wavelengths would then be looking directly at the corona rather than the photosphere of the sun. On the other hand, the angular resolving powers available at these wavelengths are a serious limitation.

The solar observations have shown that the effective temperature of the corona is of the order of one million degrees, with considerably greater energies present in the region of sunspots.

Experimentally the first problem of galactic radiation is to determine whether it comes from a diffuse interstellar gas or from point sources such as the known stars. Hey in 1947 found the 4 metre radiation from a region in Cygnus showed fluctuations which indicated that it came from a point source. Workers in Cambridge have been using systems of greater resolving power and have been able to locate this source more accurately and have detected several more.

Resolving power could in principle be obtained by making a receiving aerial system of sufficient aperture. But the most interesting wavelengths are of the order of 4 metres, so that 1 minute of arc would need an aerial about 2 miles square, filled with receiving

elements. A resolving power comparable with this is obtained by using an interference technique. Two aerials of reasonable aperture are spaced 120 wavelengths apart and the signals received on each fed together into the receiver.

The pattern is broad in a North-South plane and narrow ($\pm 3°$) in the East-West. In addition it is divided up in the East-West plane into a number of lobes each about $\frac{1}{2}°$ wide. Each half of the aerial system contains 40 half wave receiving elements in front of a reflecting screen.

As the earth rotates any source in the Northern hemisphere of the sky will pass through this polar diagram and will produce a periodically varying signal as it passes through the lobes. A point source producing a power in the aerial of possibly only 1 per cent. of the background from fainter sources would be visible on the record as a sinusoidal variation on top of a steady level.

The record gives us not only the amplitude of the received signal but also the positions of the sources. The time of the central maximum is the time the source transits the perpendicular to the aerial base line, giving the Right Ascensions of the source (i.e. the East-West co-ordinate). The other co-ordinate, declination, is found from the periodicity of the variation which is proportional to the secant of the declination. There are two major sources of radiation and their positions can be found with an accuracy of 5 minutes of arc in both co-ordinates by this method.

In addition to these two sources, 23 smaller ones have so far been observed. None of these corresponds to bright visual stars, in fact the two major sources are not stars brighter than the eighth visual magnitude. This is not so surprising if we consider that a star with a very dim surface visually may well have an atmosphere containing very high energy electrons, possibly accelerated by some electromagnetic process.

That is the rather limited experimental evidence we have so far. We want to deduce the actual particle energy of the medium producing this radiation, and can at present only make a guess at it. We need the diameter of the source and the distance from the earth. The best effort we can make at a parallax measurement puts the source outside the solar system, and as the galactic radiation is distributed at least roughly over the sky as are the visual stars, we put the distance as that of the nearest known star. An estimate of the diameter is given by the fluctuation from Cygnus and other sources including pulsations which have been observed to last for only ten seconds. Assuming that these fluctuations are due to genuine variations of the emission from the source, this puts the diameter at less than ten light seconds, for a larger body could not produce such rapid fluctuations. This is of the order of the size of an average visual star. The effective temperature of these bodies then comes out at 10^{10} °K ; unless some special mechanism is responsible for maintaining coherent oscillations of electrons in the stellar atmospheres it appears that the radiations must be due to electrons having a random motion corresponding to an energy of at least 10^{10} electron volts.

This subject of radio astronomy has only just begun, but the few results that have already been obtained show that much new information about the galaxy is within our grasp. Already we have found that the energies of particles in some stars may be sufficiently great to suggest that the origin of cosmic rays is the same as that of the radio waves we are receiving.

"THE ADVANCEMENT OF SCIENCE"

Change of Publication Dates

By a decision of the Council, the quarterly numbers of *The Advancement of Science* which have hitherto been published at the end of the months January, April, July and October will appear in future at the beginning of the months March, June, September and December. The new sequence will begin with an issue for September, 1950. The present number, for January 1950, appears at the usual date and, in the transition period, the following number will be published at the beginning of May. Two advantages of the new arrangements are that reports of the proceedings of the annual meetings will be published nearly two months earlier than at present and that members who subscribe two guineas for one year only will receive in the year of their subscription (April to March) three numbers (instead of two) containing reports of the annual meeting they attended.

THE PSYCHOLOGICAL QUALITY OF THE POPULATION

Report of a Discussion[1]

EDITED BY
JAMES MAXWELL

I

The discussion was opened by Prof. P. E. Vernon. He referred to the recent report of the Royal Commission on Population, which stressed the need for maintaining the quality as well as the size of the population. Quality was a difficult character to define, but it could be safely said that general intelligence was a quality which was desirable. Those highly endowed with 'g,' or general intellectual ability, had been found by L. M. Terman and others to be superior in other desirable qualities such as physique, health and character. Delinquents, also, tended to have intelligence below average. There was also the advantage that a fairly well-developed technique for measuring intelligence was available.

Table I

	Non Manual	Skilled and Semi-Skilled	Un-skilled
Heads of families in existing population	30	40	30
Fathers of future population . .	19	37	44

It had been known for some time that there existed a tendency for the birth-rate of the upper social and economic classes to be lower than that of the so-called lower classes. Burt, in 1920, found that the average size of family of children attending one of the best London schools was 2·9, as compared with 5·2 for one of the poorest schools. Table I, from the Merseyside Survey, showed the same features.

This same feature of differential birth-rate according to social class appeared to be common throughout Western Europe and the United States for the last generation or two.

The phenomenon was not, apparently, solely the outcome of social and economic differences. Thomson found, within the fairly homogeneous class of coal miners, the same tendency for the more intelligent children to belong to smaller families. Further investigations by Burt, Thomson, Cattell and the Scottish Mental Survey all pointed in the same direction. All these investigators agreed very closely that the net result was likely to be a decline in average intelligence of about 2 points of IQ per generation of about 30 years. Burt, on an estimated decline of 1½ IQ per generation, predicted the future levels of intelligence as in Table II.

The most alarming feature was the indication that by the end of the century the proportion of very intelligent children would be halved, and the proportion of very dull more than doubled.

[1] September 5, 1949, Section J (Psychology) at Newcastle-upon-Tyne. Professor Sir Godfrey Thomson in the Chair.

Table II

Intelligence Level	IQ	Proportions in 1920	No. of Children per Family	Proportions Expected 1950	Proportions Expected 2000
Superior . .	130 and over	1·8%	2·3	1·4%	0·8%
Good . .	115–129	12·2%	2·7	10·3%	7·6%
Average+ . .	100–114	35·1%	3·3	33·4%	29·9%
Average— . .	85–99	37·5%	3·6	38·6%	40·5%
Dull . . .	70–84	11·9%	4·2	14·2%	17·9%
Very Dull . .	Below 70	1·5%	4·7	2·1%	3·3%
Average IQ .	100			98·5	96·0

It was, however, rather difficult to establish direct evidence of a decline. Burt, for the period 1920–1939 claimed that a decline of about 1·3 IQ had occurred, but it was not certain that his samples of children were directly comparable. The testing of a complete population of eleven-year-old children in Scotland failed to show any decline over an interval of fifteen years. Further, any such decline would be most noticeable at the extremes. Surveys of Mental Deficiency in 1907 and 1929 showed a rise in the proportion of Mental Defectives from 0·45 per cent. to 0·80 per cent. of the population. But it was admitted that the apparent increase was probably due to greater thoroughness of ascertainment, so no definite conclusions could be drawn.

Another element of uncertainty was introduced by our lack of knowledge of the extent to which intelligence test scores depended on environment and heredity, and the literature on the subject showed a wide divergence of views to exist. Such families as the Darwins and Galtons at one end of the scale, and the Jukes and Kallikaks at the other, showed a tendency for intelligence to be inherited. But studies, such as that by Lawrence on orphans and parents, have shown that intelligence, as measured by the Binet test, is only partially inherited. Usually the correspondence between the intelligence of identical twins was almost perfect, but in the rare cases where the environments differed markedly, there had been found a considerable difference between their IQs. Shuttleworth, in a study of twins and siblings, estimated that a child's intelligence could be attributed 64 per cent. to heredity, 16 per cent. to environment between families, 3 per cent. to differences within families, and 17 per cent. to joint heredity-environment factors, i.e. the fact that intelligent parents tend to provide superior environment. Intelligence test scores therefore, though fairly consistent, did show variations due to environmental influences. Similar studies of foster children also showed that children in better class foster homes tended to show higher intelligence. Even allowing for the fact that more intelligent parents would probably adopt superior children, it had been estimated that home environment might account for a difference of about 10, or at most 20 points IQ. During the past few years a number of studies had been published from Iowa University claiming to show still greater environmental influence upon IQ. Schmidt, another American investigator, claimed to have turned 254 twelve to fourteen-year-old children, diagnosed as feebleminded, into a well-adjusted group after three years' special schooling, the average IQ rising from 52 to 89. Many psychologists, however, were somewhat suspicious of these methods and results. Judgement must be suspended until stricter controls had been established.

Another source of uncertainty was that intelligence had been measured by different tests, not all equally good. Intelligence was best defined in terms of 'g,' i.e. the highest common factor that could be extracted from the best tests we could devise. Factorial analysis showed that the ordinary type of verbal group test was by no means a pure measure of 'g,' the scores depending almost equally on 'g' and educational ability. Practice effect might raise an IQ by 5, or at the most 10 points. Fortunately the Stanford Binet was one of the tests which showed least practice effect, and the one which was most frequently used in population studies. But even this test could claim to measure 'g' only to the extent of about 50 per cent.; about 25 per cent. depended on verbal and educational abilities, and about 25 per cent. on various other abilities, and error.

It must be concluded that psychologists have not yet solved the extremely difficult technical problem of measuring the intelligence of population samples really reliably. The IQs obtained at present were very impure mixtures, and far more research was needed into the construction of valid and practicable measuring instruments. Until this was done, it would seem premature to expect any very definite findings on problems of genetical change in the population.

II

Prof. L. S. Penrose said he proposed to consider reasons which led him to doubt whether a decline in national intelligence was taking place. Intelligence was becoming identified with scholastic aptitude, and depended therefore on variable standards. Further, the geneticist could only study scores on a test, not an abstract concept of 'general intelligence.' The pitfalls in the current theories of intelligence were demonstrated by the Wood Report (1929), where the apparent incidence of mental defect increased sharply during the school years.

But even if the scores on intelligence tests were accepted as substantially measuring intelligence, certain pitfalls remained. Similarities in environment within families increased the correlation between the intelligence of their members. Nor did the fact that a particular environmental effect might only show itself in a small section of the population mean that it was unimportant.

There was no direct evidence for a decline in the level of national intelligence other than the very dubious evidence of ascertainment of mental defect. The indirect evidence

adduced for declining intelligence was based upon (i) the supposed fact that intelligence was inherited largely as a character determined by additive genes ; (ii) the undoubted fact that children from large families do less well on intelligence tests than those from small families, and the assumed inheritance of fertility.

From these assumptions it would follow that the intellectual level of the population was declining ; but there were two other factors which must be considered : (iii) the infertility of defectives below a certain level of intelligence ; (iv) assortative mating, i.e. the tendency of like to mate with like. The observed correlation between parents' intelligence was about + ·5. In view of this, though dominance and recessivity of the genetical factors might explain the discrepancy, the observed magnitude of filial and fraternal correlations observed was not as conclusive evidence of the strength of genetical factors as was commonly supposed.

Further, if we considered the parallel characters of stature and longevity, we found both correlated negatively with family size, yet the stature and longevity of the population were increasing. It would appear, therefore, that differential fertility was not entirely due to social causes, but was a natural and permanent biological phenomenon, and, if due to heterosis, or ' hybrid vigour,' could maintain a population in a state of equilibrium. Though assortative mating would tend to disturb the equilibrium, it seemed that in human populations this was compensated for by the very large differential fertility that existed. In the lowest tenth of the population for intelligence, for instance, the family size was double that of the rest of the fertile population, but below about 50 IQ, fertility was considerably reduced, a fact which would not have shown itself in estimates based on school children.

It was possible to demonstrate a model population with all the properties usually considered as belonging to normal and problem social groups. Let us imagine a race composed of three main types determined by a single intelligence gene. (i) The pure or homozygous type *AA* was supposed to be normal, with an IQ slightly over 100, constituting nine-tenths of the population, but with fertility too low to keep up their numbers. (ii) The social problem group, constituting one-tenth of the population, were hybrid for the gene *a*, which reduces scholastic ability ; and this type *Aa* had high fertility, about double that of the normal group. (iii) Those homozygous for *a*, i.e. *aa*, were weaklings, incapable of reproduction. As the genes were additive, the mental level of this group was too low to be compatible with mating. If one gene *a* reduced IQ by, say, 30 points, two such genes would reduce IQ by 60 points. Assuming perfectly assortative mating, such a population would be in stable equilibrium. If we supposed that the numbers in the superior group were suddenly reduced, the mean level of IQ would fall below 100. But it would rise again steadily till the superior group was rebuilt. This adjustment would be accompanied by a falling birth-rate and a gradual increase in the numbers in the population, a tendency which has been observed in our own actual population in recent times.

Such models could also be constructed to allow any degree of assortative mating, as was shown in Table I.

TABLE I.—*Model Population with Parent-Parent Correlation r = + 0·56*

Genotype	IQ	Frequency	Fertility
AA . .	105·2	0·900	0·9584
Aa . .	69·2	0·100	1·6166
aa . .	33·2	0·024	0·000

Mean IQ = 100. S.D. IQ = 14·9.

Condition of Population at Equilibrium Point

Parents			Offspring		
Mating Type	No. of Pairs	Fertility	AA	Aa	aa
AA–AA .	86	1·917	164·9	—	—
AA–Aa .	8	2·575	10·3	10·3	—
Aa–Aa .	6	3·233	4·8	9·7	4·8
All .	100	2·048	180·0	20·0	4·8

Correlation Coefficients at Equilibrium Point

Parent IQ—Child IQ	Sib. IQ—Sib. IQ	Parent IQ—Parent IQ
+ 0·61	+ 0·58	+ 0·56

IQ—Size of Family : —0·35
IQ—Fertility : 0·00

In such a population there was stable equilibrium despite the fact that IQ and Sib number were negatively correlated.

The conclusion was that probably the intellectual level of the population, though subject to fluctuation with environmental changes, was based on a stable genetical system. There appeared no reason to believe that mental deficiency was increasing, except in so far as standards of social competence were becoming more stringent. Finally, it was reasonable to regard that part of the population which was most fertile but least

adapted to scholastic training as a necessary and normal part of the structure giving genetical stability to the whole group.

III

MR. J. MAXWELL said that the ideal way of ascertaining whether there had been any alteration in the average intellectual level of the population was to measure the intelligence of two equivalent groups in the population, under the same conditions, at stated intervals of time. The Scottish Mental Surveys of 1932 and 1947 were a part, but only a part, fulfilment of these requirements. The 1932 Survey was undertaken by the Scottish Council for Research in Education, and 87,498 eleven-year-old children were given a group intelligence test. In addition to this, an individual test, the Stanford Binet, was given to 1,000 of these children born on or near June 1. In 1947 the survey was repeated. The same group test of intelligence was given to the corresponding group of eleven-year-olds ; but the size of the group had decreased to 70,805 during the fifteen years' interval. To 1,200 of these children, also, was given the Terman-Merrill revision of the Binet Test.

There were, therefore, two sets of comparative scores, the group test scores for the whole group of eleven-year-olds and Binet Test scores for a sample of each. After adjustments had been made for sampling and the fact that a different revision of the Binet test had been used on the two occasions, it was found that the average Binet IQs on the two occasions did not differ significantly. There was, therefore, no evidence of a fall in the average intelligence of Scottish children, as measured by the Binet Tests—and no evidence of a rise.

In both surveys the same group test was given, so that direct comparison was possible. The average score in 1932 was 34·4 points, and in 1947 the average score was 36·7 points, an increase of 2·3 points of test score. But it was very doubtful if the conditions were exactly the same. In 1932 the children had little experience of intelligence tests, whereas in 1947 many children were to a greater or lesser degree familiar with the technique of intelligence tests. There was, however, a group of education authorities who had virtually no previous test experience in 1947, and their test scores could be compared with those of the same education authorities in 1932. These nine authorities were distributed fairly well geographically, and contained areas with both high and low average test scores. When the 1947 and 1932 average scores for these areas were compared, the 1947 score was found to be 0·4 points higher than that in 1932, as compared with the increase of 2·3 points for all Scotland. There was, also, a larger group of fourteen education authorities who were now using tests fairly extensively. In these areas, the average 1947 score was 3·2 points higher than in 1932. It was reasonable to assume, therefore, that part, at least, of the general increase in test score was due to ' test sophistication,' but exactly how much was uncertain.

The evidence of the test scores, therefore, led to a verdict of not proven. There was, however, another approach to the question. For each child in the 1947 survey there was completed a sociological schedule, in which, among other things, was recorded the child's birth order in the family, and the number of children in that family. The group test score and the size and position in the family were both known for 70,200 children. The relationship between test score and family size could therefore be calculated. As compared with the average score of 36·7 for the whole population, the average score for only children was 42·0 points, that for children from families of five was 32·5 points, from families of ten 26·9 points, and from families of fifteen 18·0 points. The correlation between family size and intelligence test score was $r = -\cdot 28$. Though there was considerable overlap in the range of intelligence for differently sized families, the general tendency for children from the larger families to have lower average scores was unmistakable.

Possible reasons for this phenomenon were many, and full analysis of the data was not yet complete. Certain possibilities could, however, be examined. If there was a tendency for the first-born in a family to be more intelligent than the second, the second than the third, and so on, it would follow that the average intelligence of larger families would be lower than that of smaller families. The data, however, showed no clear relationship between intelligence and position in family. There was apparently a very slight tendency for first and last-born to be a little more intelligent than the others, but caution was necessary here, as it was not certain in many cases whether the family was completed or not.

Another possibility was that the children who enjoyed the most favourable social, economic and cultural conditions were also those in the smaller families. We could not directly measure these conditions, but we could obtain a rough assessment of them by considering the father's occupation. For 7,380 children, those born on the first three days of each month, there was completed a larger sociological schedule, known as the Random-Sample schedule, in which was recorded, along with other information, the father's occupation and the mother's date of birth. The average score of children from the

professional group was 54 points. Children of employers of labour, salaried employees and clerical workers had an average score of around 45 points ; children of skilled manual workers and farmers had an average of 36 points ; and children of unskilled manual workers had an average score of 31 points. These differences were considerable. Also, the correspondence between the average test score of the children and the average size of family was virtually perfect. The professional group, with an average family size of 2·4, had the highest average intelligence test score, and so on to the unskilled workers, with lowest average test score, who had an average family size of 4·5. But it was also found that within each of these occupational groups the average test score of the children decreased with increasing family size. The decline in test score per unit increase in family size for the whole population was roughly one and a half points. For children of professional class fathers, the decline was also about one and a half points. For employers' children the decline was just over two points. For skilled manual workers it was again about one and a half points. For children from the other occupational groups the decline was of the order of one point of score per unit increase in family size. There was again no doubt that the same trend was evident, irrespective of the parents' occupation, and the attendant social, cultural and economic advantages or disadvantages. It appeared, indeed, to be more marked than otherwise in the families of parents of superior socio-economic status.

There was one further line of investigation for which the data were at present available. The mothers of some 800 of the children were over 36 years old when the child was born, and about the same number of mothers were 21 years old or less. The two sets of mothers represented generations at least fifteen years apart. The mean scores of these two sets of children were both below the average of the whole population of eleven-year-olds, but the two groups are not strictly comparable. The children of the older mothers were either at the tail end of large families, or were members of smaller families who had been born late. Almost exactly the opposite held of the children of younger mothers. But despite these differences, the same phenomenon of decreased score by increasing size of family was clearly evident in both groups, more so with the older mothers than the younger. Again, therefore, this tendency was manifest despite differing conditions.

Whether this relationship between family size and average intelligence necessarily implied a progressive lowering of the intellectual level of the population was not yet established. There was evidence from the data collected by the Royal Commission on Population which indicated that differential fertility was a feature of fairly long standing. There was some evidence, however, that the reduction of family size by the more intelligent parents was reaching its limit. But more information was needed before any prediction could be made. We were not aware of the mechanisms of the inheritance of intelligence, whether the less intelligent children from large families would be the parents of large families of less intelligent children, or whether a fairly constant level was maintained by some such process as that described by Prof. Penrose. We would also need further surveys similar to the 1947 survey carried out at intervals, in order to ascertain any changes in the intelligence-family size relationship. This should be supplemented by family surveys, in which the intelligence of whole families, rather than selected children, would be measured. This would be an undertaking which would be spread over many years, and would require the resources of a considerable organisation behind it.

Plans had, however, been made for the following up of the future progress of some 2,000 of the survey children. Prof. L. M. Terman and his colleagues had followed the careers of a group of highly intelligent children in California. Now, twenty years later, these children occupied positions from international eminence to semi-skilled labour. The survey group would be representative of all levels of intelligence ; and the various influences, such as personality traits, home conditions, educational opportunities and so on, which determined successful living, would be investigated.

The follow-up was an essential part of the Mental Survey. The Mental Survey itself had taken us one step further in our attempt to assess the intellectual resources of the nation. The follow-up was an attempt to assess how far these resources were being fully utilised.

IV

Mr. D. Kennedy-Fraser gave an account of the individual testing of the Six-Day Sample of the Scottish Mental Survey children. These were the children born on the first day of each of the even months, February, April, etc., and it was hoped by this means of selection to obtain a truly representative sample of the whole population. The first estimate of the number of children in the Six-Day Sample was 1,171, but further investigation showed that some of these were not born on the required dates, and additional cases came to light. The final sample consisted of 1,230 pupils, of whom 1,215 were tested. The missing fifteen consisted partly of itinerant

children who moved too rapidly around the country for the testers to keep track of them, and children such as one whose home was on an island in the Pentland Firth, where it would have meant a stay of two weeks for the tester, owing to lack of transport facilities.

The testing was carried out by a large team of testers, about 150 in number, under the general direction of the speaker. Assistance was obtained from teachers, directors of education, educational psychologists, and members of Training College and University staffs.

The test used on this occasion was the Terman-Merrill Revision of the Binet Test, Form L. Though there were reasons for using the Stanford Revision as in 1932, it was finally decided to use the Terman-Merrill Revision, as mentioned above. This testing gave an excellent opportunity of standardising the Terman-Merrill test for Scottish children. It was found, for instance, that the mean IQ for the Scottish children was 102·5 points, which was significantly superior to 100. The standard deviation of IQ was 20·1, which was equivalent to that found in U.S.A. for the twelve-year-old age group. It was possible that this greater spread is due to the fact that the tests for the higher ages appear to be too easy for Scottish children. When, however, the standard deviation was adjusted according to McNemar's scheme to that of the Stanford Binet, the 1947 survey and 1932 survey distributions were very similar. It was also noted that the average IQ of the Scottish boys was superior to that of the girls, and that of children attending city schools higher than that of the children attending the country schools.

Since different tests had been used, it was necessary to adjust the Terman-Merrill IQs to their Stanford equivalents. Comparison of the scores of eighty-nine children to whom both versions of the test were given showed that the Terman-Merrill Revision appeared to be about 2½ points IQ easier than the Stanford Revision. A detailed comparison of the 1947 and 1932 Binet testees was made by Dr. Fraser Roberts, who reached the conclusion that there had been no substantial change in Binet IQ between 1932 and 1947.

Apart from comparison of the two surveys, the administration of the test to a representative group of Scottish eleven-year-olds had considerable value in itself. It had confirmed several features which testers had suspected for some time. The Terman-Merrill standard deviation was considerably larger than that of the Stanford Revision, and the mean IQ on the test in the region of eleven years was higher than 100. It also appeared that the adult levels of the test were too easy.

FOOD AND PEOPLE

In 1949 a major experiment was begun by Unesco who asked that, in each of the member states of that organisation, there should be public discussion of a single theme of world-wide importance. The theme chosen for 1949 was ' Food and People ' and the British Association's Division for Social and International Relations of Science arranged a large public meeting on this topic. The meeting was held in the City Hall, Newcastle upon Tyne on Saturday, December 3, during the Annual Meeting of the Association. It was open to the public and the audience, who were given on arrival publications prepared by Unesco, numbered nearly a thousand. The President of the Association, Sir John Russell was Chairman of the meeting, the main speakers were drawn from France, Britain, Canada and Australia and they discussed the contribution which the British Commonwealth could make to the solution of the general problem. The main addresses were followed by answers to questions previously submitted in writing and the whole proceedings were recorded for subsequent use in broadcasting. The following are the texts of the main contributions to the discussion.

Prof. Pierre Auger

It was in this ancient city of Newcastle that the world-famous engineer, George Stephenson, a century and a quarter ago established the ironworks where were built the first steam engines that went puffing into history between Stockton and Darlington, and Manchester and Liverpool—and began a new and splendid phase in industrial development. There were never in Britain organised riots against the introduction of the railway as there had been a decade or so earlier against the introduction of new machines in the cotton industry.

The reason is clear. The railway was never regarded as a menace to the livelihood

of the community. On the contrary, the extent to which it opened up new territories and expanded trade was clear to all. Science and technology as expressed through Stephenson were, as even the blind could see, of benefit to mankind.

However, in school textbooks this is rarely directly expressed ; and somehow, the student arrives at man's estate never quite certain as to whether science is a friend or an enemy. He too often takes a lukewarm Luddite approach, regarding the machine—the product of science—as something undesirable.

We must take a firm stand against this attitude, for that way lies disaster. It is not the machine or technology that enslaves man, but man himself. If man wishes he can use science and technology to free himself, to rid himself of illness and disease, and to remove the burden of unproductive and uneconomic toil.

These are generalities which we can all agree upon. It is necessary to make their meaning real to the ordinary persons who do the workaday jobs in this world. It is no use telling them in magnificent speeches, or through lavish publications, that science can aid them if they do not see directly how this can be done.

In addition, it is necessary to prepare the ground so that any schemes that governments wish to develop shall have the support of the people through sympathetic understanding.

That is why, this year, Unesco began what is in effect a major experiment towards mass enlightenment. We have chosen a single topic on which we have asked the various member states of Unesco to concentrate through the organisation of discussion groups. The topic is ' Food and People '—a subject which concerns intimately all aspects of our life. In this are bound up the most complex patterns of social behaviour, from the cultivation of the soil to the way in which food is eaten in the home. What we aim to do is to focus attention simultaneously among the peoples of the world on this urgent problem, about which you have heard so much during this past week. In this work we are collaborating to the full with the F.A.O., the W.H.O., and the U.N. Population Division. For we wish to make clear that not only can the problems we have discussed here be solved only through international collaboration, but also that international collaboration is taking place at all levels among the already existing international organisations. In short, the Food and People discussion topic is an example to the world of how we can build for peace. We all yearn for peace, and Unesco is bound in all its activities, to promote that end.

The response to the campaign on ' Food and People ' is extremely heartening, for from every country in the world have come requests to Unesco for the special material that we have prepared. Britain, in particular, has made a magnificent contribution. Not only have the special pamphlets by world experts sold well, but in addition, the National Commission for the U.K. has distributed widely to all adult education groups, high school classes and other educational agencies, material on this subject. Further, the British Army has not been left untouched, for through the Bureau of Current Affairs discussions have taken place in many army barracks.

In the Far East, in North and South America and in the Middle East, discussions of various kinds are taking place. We are showing that the world is in reality one ; that when food crops fail, in South America for example, because of soil erosion, then the effects are felt in far away Asia.

The ' Food and People ' discussion project speaks not in a restricted language, but in one that is universal, for it is so close to what people are doing every day. There is no need for special translations when a South American peasant has explained to him why it is that he must cultivate his land and raise his cattle in such a way as to bring benefit not only to himself, but also to the busy city dweller. Through these discussions we hope to be able to make him see that his strength and well-being are bound up with those of persons whom he will probably never see, but who in turn contribute to his well-being.

Lord Horder

It is six years since Hot Springs saw one of those awakenings of conscience, accompanied by a stirring of the imagination, which from time to time affect not only individuals but nations, and which, again in nations as in individuals, tend so soon to revert to lethargy both of the spirit and of the mind. At the United Nations Conference on Food and Agriculture, held in May–June, 1943, enthusiasm ran high, defeatism was not recognised, and the best brains in the world concentrated upon the greatest of all world problems—except perhaps the avoidance of war—how to feed the human race.

The spirit of optimism which animated the conference is shown in the speech with which President Roosevelt closed the final session :

> ' You have examined the needs of all countries for food and other agricultural products, both as they will exist in the short-run period of recovery from the devastation of war, and as they will exist over the longer run, when our efforts can be fully devoted to expanding the production of food so that it will be adequate for health the

world over. You have surveyed with courage and with realism the magnitude of these problems and have reached unanimous agreement that they can, and must—and will—be solved.'

The conference offered an excellent rallying-point for experts engaged in studying the new knowledge relative to nutrition. Largely as the result of a pooling of the researches of these experts the conference ventured to sum up the nutritional position under the following four headings :

1. The kind of diet which man requires for health has been established.
2. Investigations in many parts of the world have shown that the diets consumed by the greater part of mankind are nutritionally unsatisfactory.
3. Diets which do not conform with the principles of satisfactory nutrition lead to impaired physical development, ill health, and untimely death.
4. Through diet a new level of health can be attained, enabling mankind to develop inherited capacities to the fullest extent.

Two years later the Food and Agriculture Organisation (F.A.O.), the first of the international organisations under United Nations, was set up. We were asked to advise on certain nutritional targets, taking due account of regional differences in consumption habits and possibilities of production.

It was the job of F.A.O. to find out how much food was necessary to provide the world with the requirements we laid down. The answer ran into figures which the journalist is wont to call ' astronomical.' It was found that by the year 1960, as compared with pre-war supplies, there would be a need of 60 million more tons of cereals, 30 million more tons of meat, 250 million more tons of vegetables and fruit and 35 million more gallons of milk. As Sir Herbert Broadley, Deputy Director-General of F.A.O., comments : ' a vast undertaking indeed.' Yet, such is the spirit and determination of those who lead F.A.O., there was no flinching from this gigantic task. Faced with ' damage by nature and wastage by man,' with ' disastrous exploitations of forests, ill-conceived methods of cultivation and short cuts to wealth,' F.A.O. turned confidently to the factors by which repairs could be effected, untilled land brought into cultivation, and technology harnessed to intensive production.

And who, listening to Sir John Russell's presidential address to the British Association —with his almost embarrassing catalogue of potential aids to agricultural development— who can doubt the ability of science to serve our ends in these directions ? The now famous Point IV in President Truman's inaugural address was not a mere mirage ; it was a call to action, and action based upon the established facts of science. To deal adequately with this technological position Sir Herbert Broadley pleads for a World Food Fund, which would supply the sinews of war. Sir Herbert thinks that the feeling of responsibility is growing amongst the nations. Let us hope he is not too sanguine in this, but we do not forget that Lord Boyd-Orr's effort at securing a World Food Board failed, and failed because member nations manœuvred for position and for power.

But it is not only in the technological field that effort is required ; there is also the economic problem that must be tackled. It is not only a question of producing more food ; surpluses and slumps have to be dealt with ; the food and the hungry people must come together ; the producer must not be induced to ' pull his punches ' in one place whilst human beings are being underfed in another. ' A world economy which does not provide agricultural and industrial producers with a fair basis for exchanging the products of their labours will frustrate the best endeavours to increase the supply of food which the world so much needs.'

What is the present position in respect of all this ? As the result of a world tour quite recently undertaken by the present Director-General of F.A.O., Mr. Norris Dodd summarises his observations as follows :

1. Methods of food production still in use in many parts of the world are extremely primitive.
2. The conditions under which the majority of agricultural producers live are ' terrible.'
3. Although they are producers of food, the great portion of the farmers have themselves an inadequate diet.
4. There are great possibilities of development, whether at the level of large projects of irrigation and draining or by the less ambitious method of providing the peasants with efficient hand tools. There are also great possibilities of improving agricultural production in all countries of the East.

Despite all this leeway to make up, the Director-General is not defeatist. Speaking to the United States' farmers the other day he said :

' I have faith that it is not hopeless ; on the contrary, with the help of modern science, backed up by common sense, hard work, and international good will, I believe mankind can do a far better job of producing and distributing food than ever before. I am not optimistic enough to think that the world of plenty is just round the corner, but I am sure it is down the road, and we shall eventually come to it if we only make the right start and keep moving.'

' Yes,' says the critic, ' but what about the world population ? What about Malthus's law ? ' Well, though common sense tells us that Malthus's law must be accepted, a little

thought shows that it has only a limited and a local application. Like so many ' laws ' relating to human affairs, it is an over-simplification. The desire to reduce human affairs to ' laws ' often overrides itself. It is not only in ' this our life ' that the soul gets ' a dusty answer ' when ' hot for certainties ' ; in demography the same thing happens. Applied to China Malthus's law clearly operates, or may do so. The population of China is estimated—reliable figures are not available—at between 400 and 500 million, and is probably increasing at the rate of 6 million per annum. During peace, China can feed some 400 million people on the basis of a mere subsistence level. If she desires a higher standard of living, which connotes a diet giving a better margin of nutrition and therefore of health, she must do one, or both, of two things ; either she must grow, or import, more, and more varied, food, or else she must limit her population increase. But China may do all of these things and so demonstrate that, even in her case, Malthus's law may not be operative. The time factor is clearly imperative ; will increased production, with or without importation, catch up on increased population ? Or will it not ?

In Western Europe, on the other hand, Malthus's law does not operate at all, nor has it for a thousand years—and for three reasons, as pointed out by Professor Whitehead : the expansion of commerce, the development of technology, and the discovery of empty continents. Although China cannot find more empty continents, industrial expansion and technological development have scarcely begun with her.

But there is a fourth factor which has operated in making Malthus's law of no sociological significance in Europe during recent years, and to which Whitehad makes no reference. This is the practice of some form or other of birth-control.

It has been alleged that so called ' primitive ' populations would have nothing to do with family limitation in any form, that large families are a tenet in their religion or tradition. But the view of those who have actually lived amongst such people tells a different story : the womenfolk frequently ask for information on the spacing of their children. It would seem an almost universal desire of women to seek help against the bondage of too frequent pregnancies. The working out of the principle of contraception in face of the traditional cultures and social institutions in China and elsewhere will probably fall to the lot of the women themselves. Hence the value of antenatal, neonatal, and other clinics where women may receive instruction.

Two further considerations are pertinent in this connexion. The first is that governments and other controlling authorities should not only allow, but should encourage, contraceptive instruction. Thanks largely to the work of the Family Planning Association this position has been in a fair measure, secured in this country. Public opinion, as always, has dictated policy.

The second consideration is that more research should be undertaken in pursuit of simple, but effective, techniques. I think it was that courageous and persistent pioneer, Margaret Sanger, who commented on the fact that whereas we had succeeded in splitting the atom, with certain dire consequences to human life, we had not yet found a simple and harmless contraceptive. But we shall, and perhaps by a method quite different from those in present use. In scientific discovery the wind bloweth whither it listeth and we cannot foresee the direction in which any new addition to our armamentarium towards the goal of human progress will appear. Nor, I am inclined to add, to what bad, as well as to what good, purpose man will put it.

What really matters is that we possess the will to achieve biological control, as to which many of us are still in the stage of confused thinking.

I do not mean by these remarks that I regard intensive propaganda concerning the voluntary limitation or control of births as the panacea for the maladjustment of food and population in the world. History shows that when the standard of living rises, by whatever means this be achieved, such propaganda from without a social group becomes less and less necessary. It may be said of any nation that if it raises its standard of living this matter, as many others, will be added unto it.

Sir John Russell has warned us that though science can be a very efficient provider of benefits it does not make a choice, or a decision, as to their use. That rests with the spirit of man.

But on this point, even after a second world war, I am an unrepentant optimist. I take it that a man may quote himself without being charged with plagiarism. At the meeting of this Association at Blackpool in 1936, speaking of the strain of modern civilisation, I touched on this subject. I said :

> ' I believe that " man can elect the universal man." I have faith that the human heart *is* " made of penetrable stuff." I do not think that " damned custom " has " braz'd it so. That it is proof and bulwark against sense " ; though at this moment a morbid Hamlet, looking on, would doubtless take a different view.'

I shall conclude my cursory review of the position by a statement which I may call my creed :

1. We must take a global view of the problem ; unless we do so we cannot hope to solve it.
2. We must work, for we cannot escape the injunction : ' if ye do not work neither shall ye eat.'
3. We must encourage ideas and we must secure complete autonomy for science.
4. We can, if we will, achieve physical, chemical, and biological control on the earth and thereby effect a satisfactory adjustment in regard to food and population.
5. Moral control is the ultimate and overriding consideration. Its most primitive expression is ' live and let live.' Without this even survival cannot be assured.

Viscount Bledisloe

Except in the matter of pedigree livestock Great Britain cannot be regarded as a supplier of farm products to other countries. Her dense population ($\frac{1}{50}$ of the human race) and relatively small and steadily shrinking agricultural area necessitates the absorption of her output of essential foods by her own consumers, leaving a large balance, under normal conditions, to be imported from abroad. The experiences of war, coupled with the present dollar shortage, tend to induce a restriction upon these imports, with consequent austerity in food consumption, and intensification of our own husbandry.

To what extent, it may be asked, is Great Britain contributing now, and likely to contribute in the future, to the food supply of her own people? In other words what proportion of their requirements of such essential commodities as cereal breadstuffs, meat, milk, eggs and potatoes, is her soil yielding to-day, or likely to yield in years to come?

In two only of these commodities has Britain supplied practically the whole of her home consumers in normal pre-war years, viz. liquid milk and potatoes. (The consumption of both these has materially increased during and since the last war—the former in the interests of young children and the latter as a starchy substitute for wheat imports. Their home production, however, under Government direction, has increased ' pari passu ' with their consumption.)

Pre-war home produced wheat (including flour) was 14 per cent. only of that consumed, but rose to 43 per cent. in 1944 and fell to 22 per cent. last year. Home produced meat pre-war was 45 per cent. of that consumed, falling in 1944 to 31 per cent. and rising to 42 per cent. last year. Home produced eggs were 59 per cent. of those consumed, falling to 37 per cent. in 1944 and rising to 54 per cent. last year.

Only in the bulky foods—bread and potatoes—is food consumption higher in the United Kingdom than in the U.S.A. Canada occupies an intermediate position.

Our acute war-time food shortage was due to our dependence on imports for more than half our supplies.

Pre-war, over half the meat, nearly all the fats and four-fifths of our cereal foods and our sugar were imported. During the war there were *increases* in our home production by 90 per cent. of wheat and potatoes, 45 per cent. in that of our vegetables, 25 per cent. in that of our milk and milk products and 19 per cent. of our sugar ; while there were *decreases* by 15 per cent. in that of butchers' meat, 50 per cent. in that of pig meats, 25 per cent. in that of poultry and 35 per cent. in that of fruit.

In the matter of nutrition research work between the two World Wars revealed the fact that nearly half our population were not getting in the food that they consumed sufficient of the requisite nutrients in the form of calories, protein, vitamins, and minerals, notably calcium.

With the outbreak of war, Government food control, under scientific direction, has enabled these deficiencies to be to a material extent rectified.

In Britain there was for about 70 years no very marked increase in the pre-war yield per acre of wheat, which stood at an average of from 30 to 32 bushels, rising during the last decade to 35 bushels. (The yields in Holland and Denmark are normally 33 per cent. above ours.) On the other hand, there has been a marked increase during the last 20 years in the yields of our fodder crops, notably grass, and a considerable increase in the milk yield per cow from a deplorably low average pre-war level.

Looking back over the last ten years, one cannot but realise that there has been a veritable agricultural revolution in this country and one that is calculated to have permanent effects—mostly of a salutary character—upon the British countryside and upon its true economic function and justification. Its most striking feature is the great rise in the level of agricultural production. Our farming industry pre-war was in a state of chronic stagnation, suffering from half a century of depression and impoverishment (which drove out of it many of its most competent practitioners and their capital) broken only by a temporary, but restricted, First War boom, which, however, subsided in the early thirties. The conditions of the blockade in the Second World War compelled Britain, whose husbandry had been based preponderantly for several generations upon her livestock, to switch over in most areas to arable cultivation,

as a means of providing as much food as possible for human consumption. During the six years of war, the area of her arable land was extended from 13 to more than 19 million acres, with a marked increase in wheat, potatoes and vegetables. Concurrently most of the concentrated feedingstuffs, formerly imported, were replaced by home-grown supplies. This resulted in a 30 per cent. net increase in the volume of our agricultural output.

The ploughing up of grassland materially affected livestock husbandry, particularly as farmers were forbidden to feed to farm animals all crops humanly consumable, except oats, chat potatoes and tail corn.

First priority was given to the needs of dairy cattle, which enabled their number to be increased by 300,000. The number of pigs, poultry, beef cattle, and sheep declined very considerably. At the end of the war, Britain's lack of hard currency, coupled with shortage of food in Europe and Asia and war-time sales of oversea investments, disappointed the nation's hopes of a much improved diet and its farmers of an early return to normal livestock farming. Economic necessities compelled the maintenance for a long period of an arable economy, a necessity accentuated by Britain's contribution to the food requirements of war-devastated areas on the European continent. In face of the world-wide food crisis of 1946, the milling extraction rate of our flour was increased (at one time—1942—up to 85 per cent.),bread rationing was introduced and the rations of our livestock were reduced below war-time levels. Since that time the position has somewhat improved, but the dollar crisis is at present most acute and Britain is still concerned with seeking economic remedies from her own resources. This has meant that, while some other countries have largely returned to their pre-war economic pattern, including a reversion from arable crop to livestock production, British farmers have been set the dual task of maintaining roughly the war-time tillage area and at the same time expanding substantially livestock production. These two objects together comprise the 'Agricultural Expansion Programme' initiated in August 1947. This, if and when fulfilled, will secure by 1952 a supply of food from domestic sources which, in terms of calories (estimated at 3,000 per head per day), will be one-third above pre-war. At the same time, through increased home output of fodder crops and grass, it is hoped to save the equivalent of about four million tons of imported feedingstuffs. (We are realising, at long last, that unripe leafy grass is the most valuable of all animal foods.) Thus total agricultural net output is intended to be 50 per cent. above that reached at the outbreak of war. As for the foodstuffs which cannot be produced at home, Britain is aiming at greatly increased supplies from the sterling area and our own oversea territories. At the end of the Marshall Plan period the total supply of food to the population of the United Kingdom is likely to approach the pre-war volume, although in its composition and balance the diet will not be fully restored to its pre-war level.

Under the Expansion Programme there is expected to be, by 1952, an increased agricultural output of a value of £100,000,000. Half of it is to be secured from additions to the resources of the farming industry and the other half from increased efficiency. This means an improvement in efficiency by at least 2 per cent. per annum which is quite a formidable undertaking. Approximately half of the increase in output is envisaged from livestock based on grass or imported feedingstuffs, and the other half from arable husbandry. A grassland improvement campaign forms an important part of the programme of increased domestic production. Special emphasis is laid on ley farming as a means of maintaining the fertility of arable land and at the same time improving the yield of grass for feeding purposes. Marked improvements have already been achieved, both in the production and in the preservation of grass, mainly by means of grass driers and silos.

If the plan succeeds, within the next three years our permanent grassland will have been reduced by one-quarter compared with pre-war, while tillage land will have been extended by 60 per cent. In addition, much of the increased production from arable farming will be in the form of animal feedingstuffs, and (as farmers are now permitted, if they wish, to retain for stock feeding all the barley and oats of their own crop), the building up of livestock numbers will, in the main, rest upon home-grown feedingstuffs, *including especially grass*. At the end of the period the total output of livestock will be substantially greater than pre-war and imports of feedingstuffs substantially less. The production of milk already having expanded substantially, the main emphasis for the future in the sphere of animal husbandry will be on meat.

Capital expenditure (private and public) required in the industry for the four years to the end of 1952 is estimated at £450,000,000, about half of which will be spent on machinery, including machinery replacements. This means that almost 5 per cent. of the nation's present high total of capital investment is going into farming. Much of this will be represented by heavy tractors, combine harvesters and grass driers. The number of

tractors alone has risen from 50,000 before the war to 250,000 to-day and further increases are expected.

Even allowing for all this labour-saving plant and machinery, many additional farm workers will have to be found, and more and better cottages will be needed for their accommodation during the next few years. The prolonged depression of our agricultural industry in the past has proved a serious obstacle to the provision of decent homes for our country workers. Large sums of public money are being spent on Farm Institutes, Agricultural Research Stations, Agricultural and Veterinary Colleges and Experimental Farms. There is an ever increasing demand for fertilisers. Their consumption is at present 2½ to 3 times as high as it was before the war.

When once the expanded level of output—50 per cent. above pre-war—is achieved, it is expected, taking one product with another, to be maintained and possibly improved upon. Whether it can be maintained without undue cost to the taxpayer or consumer, will, however, depend on efficiency of production. The Agriculture Act of 1947, seeks to secure this efficiency and raise the national standard of husbandry both by offering farmers guaranteed prices and assured markets, and by measures of control, deemed necessary to ensure reasonably good farm and estate management, with the ultimate penalty of dispossession, if grossly inefficient. Main reliance is placed on the provision of technical advice to farmers and landowners and the general oversight of their activities, by the County Agricultural Executive Committees. The execution of Government policy is left largely to these Committees. The National Agricultural Advisory Service, set up in 1946, is intended to provide technical advice, free of charge, to all those engaged in agriculture and horticulture. As the County Advisory Officer is also the Executive Officer of the County Agricultural Executive Committee, close co-ordination of effort is aimed at. One function of this Advisory Service is to bring the more economically valuable results of the scientific work of the Agricultural Research Institutes to the farming community with the least possible delay, and explained in language intelligible to them. Acting in concert with the Advisory Service is an Agricultural Land Service, concerned with maintaining and improving the standards of farm and estate management. The aim of all these new developments is to obtain maximum output at minimum cost. (The farming industry is expected by a continuing increase in efficiency to augment its output per man by at least 2 per cent. per annum.)

Forgive me if I interpolate some reference to pig production. In the light of my experience at the Ministry of Food in the First World War I suggested in a paper which I read before the British Association at its meeting in Edinburgh 28 years ago, that the most secure basis for Britain's food supply in war-time was to be sought in a largely increased production of pigs, potatoes and milk, the justification for the first two being their rapid reproduction of protein and fat in the case of pigs and of starchy food in that of potatoes. But during the Second World War, while potatoes and milk were encouraged, a discount was placed upon pigs, as also upon poultry, as being severe competitors with human beings as regards their food. The food ration of pigs and poultry was cut progressively from one-third to one-eighth of pre-war, with the result that there was a decrease of the former by 60 per cent. and of the latter by 40 per cent. To-day we are being urged to grow more wheat, owing to the dollar shortage (and I will not attempt to challenge its justification) but if our rations are to be properly balanced for optimum efficiency, the crying need for the next few years is likely to be protein and fat, which pigs can so well and so rapidly furnish. I have lately been on ' goodwill missions ' for the Royal Agricultural Society of England to farmers in different subtropical parts of the British Commonwealth with the result that I strongly favour a large increase in such areas in the production of pigs (the only farm animal that does not suffer from any serious tropical disease), especially as ideal pig foods can be grown in these regions. I rejoice to learn of the scheme for raising in Central Queensland, with a view to an increase in our bacon ration, several million bushels of grain sorghum (commencing with 1¼ million this year) feeding it ' in loco ' to 1,000 sows and their progeny) and incidentally despatching to this country an initial cargo of 20,000 tons of such grain to augment the scanty supply of food for Britain's own pigs. This alone should represent an additional 3,000 tons of home-raised pig meat.

One hopeful factor in augmenting the supply of our home-grown food is the conduct of a more vigorous and better organised attack upon preventible animal and plant diseases and pests. A potential gain of at least 25 per cent. in each direction may be looked for. Our English Department of Agriculture was established exactly 60 years ago this year, with the object of combating such contagious animal diseases as Pleuro-pneumonia, Cattle Plague and Foot and Mouth Disease. The first two have long ago been wiped out, but there are occasional outbreaks of Foot and Mouth Disease, which, with Tuberculosis, Mastitis and Contagious Abortion, reduce materially our output of

milk and meat. Forty per cent. of our bovines are said to react to the tuberculin test, although probably less than half a per cent. yield tuberculous milk. If all reacting animals were slaughtered, as in the U.S.A. and Denmark, there would be a milk famine here. Pasteurisation of our urban milk supply is sought as a palliative. It is estimated that 25 per cent. of Britain's dairy cattle suffer from Mastitis and over 30 per cent. from Contagious Abortion, and that the annual loss of milk from these three diseases is about 200 million gallons. The estimated annual monetary loss from preventible bovine diseases is put at £28,000,000. This is largely due to our deficient veterinary service. As shown by the Loveday Report published in 1945, the only other civilised country which has less than 100 veterinary surgeons per million of the larger domesticated animals is France, and she is the only one of the Western European Countries which has an average milk yield per cow lower than ours. A 10 per cent. increase in the number of *experienced* veterinarians, exercising proper control, might well result indirectly in a 12 per cent. increase in the nations home raised protein food within the next five years.

Among our most notable food plant pests to-day, apart from rodents, are potato eelworm, potato blight, virus ' yellows ' in sugar beet, wireworm and ' take-all ' (*Ophiobolus graminis*) and eyespot in wheat, the three latter owing their prevalence to the ploughing up of old pasture and overcropping with white straw crops during the war.

To sum up, what, it may be asked, are the future food producing potentialities of Great Britain ? (I carefully do not say ' probabilities,' as these are naturally limited in a great industrial country like this by questions of international commodity exchange and other factors governing national economic policy.)

With the vastly expanding mechanisation of Britain's husbandry (enabling both economy of labour and rapidity in the execution of farm operations during intervals of fine weather), the greater application of science to the tasks of the husbandman (particularly in regard to the improvement and utilisation of his grasslands), a considerable expansion of the veterinary service, the extension of artificial insemination of livestock, the better education of the young farmer, the economic stimulus afforded by Government-guaranteed prices for the chief food products, the gradual but courageous elimination of grossly inefficient food producers, the National Agricultural Advisory Service (when fully developed) and the gradual suppression of animal and plant diseases and pests, an average increase of at least 20 per cent. in the present output of home-raised food (even allowing for the steady shrinkage of our agricultural area), is a by no means excessive target at which to aim, and its achievement would materially add to the nation's security and physical well being.

In estimating Britain's food requirements, account must be taken of the higher average standard of nutrition (so essential to national efficiency, health and happiness) at which all parties in the State have aimed for many years and in which we who belong to the British Commonwealth and Empire seek to set an example to the whole world.

In face of many handicaps, Great Britain can, I think, legitimately claim to be making a substantial contribution to the food requirements of the world. There are not many countries which have increased net agricultural output by thirty per cent. since prewar days and are realistically contemplating a further increase to fifty per cent. above that level within the next five years. In spite of all her efforts, however, Britain will continue to be, as in the past, the greatest importer of foodstuffs. However great our productive potentialities, taking food to Britain will never be like ' carrying coals to Newcastle.' This means that her national effort must be supplemented by the closest co-ordination of her plans with those of the main surplus-producing areas, in particular those of the British Commonwealth and Empire. Only thus can she hope to make the most profitable contribution to the solution of one of the most burning problems of our time—the feeding of the people of the world, at such a standard as to secure their optimum health and vocational efficiency.

Dr. P. O. Ripley

It is indeed an honour and a privilege to present some information with regard to agricultural production in Canada. In these strenuous days of food shortages and forecasts of even greater shortages in the future a relatively new country is looked upon as one of the remaining frontiers where an expansion in food production may be anticipated. Let us look at some of the facts.

The total area in Canada is 1,282,000,000 acres, approximately 22 times the total area of England, Scotland and Wales. However, the occupied farm land in Canada is only 173,563,000 acres or 13 per cent. of the total. Much of this area is in permanent pasture or rangeland and woodlots. Compared with some 46 million acres of agricultural land in Britain, this area is less than 4 times as large. The improved agricultural land in Canada is only 91 million acres or about

7 per cent. of the total land. It is estimated that between 40 and 50 million acres are available for development under present-day agricultural economy. Thus a total area of 140 million acres are now used for the production of field crops—including summerfallow, and cultivated and natural pasture, with a potential area of 180 to 190 million acres which might be used for this purpose.

It is possible that with a higher technical level for production, and a forced economy demanding increased production, the agricultural area might be increased by another 100 million acres.

The huge remaining area of approximately one billion acres in the Dominion of Canada is occupied by the Rocky Mountains, the rocky pre-Cambrian shield of Northern Canada, numerous lakes and the perma frost and Tundra area of the north. Many of these areas, although extremely rich in mineral wealth and some forest, are entirely unsuitable for food production. In addition, it must be remembered that the growing season is only 5 months or less and stable feeding of livestock must be resorted to during the other 7 months. Thus can be seen the possibilities for expansion together with some of the limitations.

In spite of the limitations however, Canada has been able to make at least a small contribution to the world's food supplies. In the 75 years from 1871 to 1946 wheat production increased from 17 million bushels to 421 million per year. The average production in the three years 1946 to 1948 was 382 million bushels or 22 times more than in 1871. The last estimate of the 1949 production is 391,500,000 bushels. Post-war distribution of Canadian wheat has included exports of some 225 million bushels annually, mostly to the United Kingdom.

The production of oats was increased from 42 million bushels in 1871 to 400 million bushels in 1946, an increase of 852 per cent. Thirty million bushels were exported in the latter year.

Only 11½ million bushels of barley were produced 75 years ago. In 1946 this had increased by 14 times to 160 million bushels.

Butter production increased in the same period by 216 per cent., from 103 million pounds to 326 million. Four million pounds were exported in 1946.

Cheese production, only 55 million pounds in 1871, had been almost trebled in 1946 to 147 million pounds. Of this amount 106½ million pounds were exported. In 1946, also, nearly 300 million pounds of bacon were exported.

Further evidence of Canadian production may be illustrated by comparing the value of food exported with that of some of the other important commodities in a relatively normal pre-war year of 1939.

The most valuable single commodity exported in that year was newsprint valued at 107 million dollars. Wheat was second at 84½ million dollars. Others followed in the following order :

3rd	nickel at	$49,566,000
4th	copper at	42,190,000
6th	meats at	35,376,000
8th	fish at	25,623,000
9th	aluminium at	24,792,000
10th	automobiles at	22,807,000
14th	asbestos at	13,266,000
16th	cheese at	12,053,000
27th	barley at	7,998,000
29th	vegetables at	6,733,000
34th	tobacco at	4,766,103
43rd	milk (processed)	3,428,000
52nd	butter at	2,092,000

Selecting only food materials from the list of exports they made up almost 180 million dollars worth of exports or approximately 20 per cent. of the total.

These few illustrations may serve to show something of the present status of agricultural production in Canada, but it is still not quite good enough. Investigations and developments are under way whereby it is hoped to make the present 140 million acres of agricultural land more productive, to bring the 40 million acres of good but undeveloped agricultural land into production and push back the frontiers to make possible use of the 100 million acres of marginal land.

Wheat, being the chief food commodity produced, is receiving special attention. Varieties of high yielding capacity and good milling quality have been and are still being developed. Millions of dollars are being spent annually in a search for more disease resistant varieties. In 1944 it was estimated that the growing of rust resistant varieties has increased the average annual wheat production by over 40 million bushels. But Thatcher, Renown, Coronation, Regent and Saunders varieties, although an improvement on previous ones, are not good enough and better strains are still being sought.

Wheats which will use less moisture are being developed so that higher yields may be obtained on the 20 million acres of arid prairie land which receives an average annual rainfall of only 12 to 18 inches, with many years much less.

Summer-fallow methods are being studied at some ten different Experimental Stations to devise better means of conserving moisture and preventing soil drifting. Strip cropping, cover crops, trash cover, ploughless fallow, have all contributed to soil and moisture conservation with resulting higher yields.

Under the Prairie Farm Rehabilitation Act (P.F.R.A.) 108 large-scale water development projects had been completed in 1947, whereby it became possible to irrigate over 200,000 acres of thirsty land for the production of canning crops, sugar beets, lucerne to supply supplementary feed for beef cattle on range lands and to increase the yield of other crops.

An appropriation of $15,000,000 has been made available for the construction of a dam on the St. Mary's river in Alberta, which will provide water for the irrigation of 465,000 acres of land. Work is well under way on this project which is the largest of its kind ever attempted in Canada.

Another irrigation project is planned at Red Deer, Alberta for the irrigation of 500,000 acres of land and in addition for the production of electric power. A sum of 66 million dollars has been set up for another long time development on the South Saskatchewan, for the production of hydro electric power, water supply for several prairie cities, and the irrigation of 800,000 acres of land.

In addition to these large scale water developments, provision has been made for 27,916 dugouts for water supply for men and animals, for 4,663 stock watering dams, 1,069 small irrigation projects for farm gardens and the development of 75 community pastures for the improvement of 1,412,860 acres of range land for beef production. This development work is being continued and expanded.

In order to explore the possibilities of agricultural production in the extreme northerly areas experimental farms and testing stations have been established up to and beyond the Arctic Circle. Early maturing and frost resistant varieties of vegetables, fruit, cereal and forage crops are grown at these points and more adaptable varieties are being developed. Livestock is also being introduced into these areas.

Soil surveys are being conducted with the idea of classifying the soils and appraising their value for crop production. These surveys are also valuable for determining the potential agricultural land which may be available, for providing a basis for the efficient placement of settlers on new land, for the zonation and adaptation of crops and farm management systems, and to provide a basis for other lines of agricultural research.

Soil conservation studies are being undertaken to learn more adequate methods of soil and crop fertilisation. Drainage surveys and studies are being undertaken. Soil erosion control is being investigated and measures are being adopted for the prevention of this menace. Peat and marsh lands are being reclaimed and made productive. Soil organic matter is being studied in those areas where continuous cash crop production has been carried on with its inevitable deliterious effect on soil structure and soil fertility.

Weed eradication methods have been studied extensively and over 4 million acres of grain were sprayed with dichlorophenoxy acetic acid and other sprays in 1948.

Grassland is receiving considerable attention in Canada as it is in other countries. Hardy varieties and more nutritious varieties of grasses and legumes are being developed. Improved grazing methods are being studied. The carrying capacity on many pastures has been increased in some cases from one animal to 3 or 4 acres to one animal per acre. Better methods for the making of hay and silage from these grasses have been investigated and developed.

Livestock improvement has received considerable attention. Better breeding has resulted in more and better quality in the milk of dairy cows. Beef cattle have been improved and bacon hogs and sheep have been developed for conditions peculiar to Canada. Feeding studies have also been undertaken with all kinds of livestock and their housing and health conditions improved.

So, it may be expected that Canada, as an agricultural country, will continue to extend her frontiers and materially increase her production. The progress may be slow and whether her production along with that of other countries may come ' too little and too late ' to meet the increase in world population will be a matter for history to record. I think I can speak for our people, however, when I say we are willing to co-operate to the utmost of our powers in order to produce more food and make the world a better place in which to live.

Sir David Rivett

I HAVE been asked to speak on the contribution which Australia is making by science and agriculture towards the feeding of the world's millions. A colleague at home who knows more of this subject than I do, writes that he is glad he is not to deal with it here tonight for we Australians cannot, he adds, be at all complacent about the contribution which we are making towards feeding the world's people.

I make a preliminary confession at once that many of us are far from satisfied with our achievements to date The rate of development is so slow : the handicaps are so many : the results so disappointing that we are conscious far more of a sense of failure and even of frustration than of any glow of success. An effective, rapid contribution to the feeding

problem of today demands more powerful catalysts than have yet been applied.

If any of you entertain the notion that in Australia the British Commonwealth possesses a marvellous asset of vast potentialities, that it is a young land capable of superlative development, by direct transfer of the proved practices of countries such as Britain, please drop it at once. Australia is geologically old, with most of the weaknesses that old age brings to soils, aggravated by our public enemy No. 1, shortage of water.

So keep in mind while I talk that the battle for food production in Australia is no easy fight ; it is a land of struggle and the struggle grows harder with every advance. Moreover, like you here, many of us prefer well paid urban industrial life to rural agricultural effort, often in isolated areas.

Of our three million square miles, one third is on present knowledge practically useless ; one third receives an erratic rainfall of 10–20 inches per annum, and the remaining third can place reasonable reliance on more than 20 inches from the skies, and it is the productive area—a crescent-shaped belt down from the eastern side of the continent turning west in the southern States and cutting off a slice, in the South-West, of Western Australia.

The relatively easy reliable and immediately profitable parts of the crescent are occupied, though not as a rule at maximum density. Even in them the spectre of drought is all too often before the agriculturist and pastoralist. Safety and further development call for broad programmes covering large-scale water conservation, irrigation and hydro-electric schemes : for modern farming makes imperative demand for cheap power.

I must not bore you with figures, but, just by way of illustration of present needs, we plan in the South-East to put £180,000,000, over thirty years, into the harnessing of the Snowy River to yield 1½ million kilowatts of electricity and to pour itself into the existing irrigation systems of the Murray and Murrumbidgee Rivers—miserable enough rivers all of them on American standards set by the Mississippi, but still the best that Australia has.

We shall increase the Hume Weir on the Murray to hold 2 million instead of its present 1½ million acre-feet of water. We plan a doubling of the Eildon Weir in Victoria by the State Rivers and Water Supply Commission which will spend £30,000,000 in the next ten years. This Commission can at least act hopefully. The £14,000,000 that it has already spent on water conservation and distribution in past years, yields, so it estimates, increased production today worth the same figure *per annum*.

Up in the North, a dam on the Burdekin River 100 miles from the mouth, will impound up to 5 million acre-feet of tropical flood water, which can then render productive about 500,000 acres. Another, across the Ord River further to the North-West, should suffice for 100,000 acres.

These figures mean little if one does not know the country. I thrust them at you that you may realise what has to be achieved before one can even begin ' to think Imperially ' about these lands. But water, though essential, is only a start. Every tyro in soil science, though unfortunately not every engineer, knows that bringing water and soil together is not necessarily the beginning of a great chapter of plant and animal production : it is often enough the beginning of a series of exceedingly difficult chemical problems on the solution of which the whole future of an irrigation project may depend.

There must be high-class scientific knowledge and experimental work all along the line : a fact that is perilously easily overlooked by national planners of these days. The study of natural pasture species under irrigation, the introduction of suitable new species, the growing of fodder crops for fattening stock or as drought reserves, the establishment of legumes to improve the nitrogen status of the soils—all these clamour for attention, calling for men, money and time. And need I mention the demand for roads and railways and their cost in these wide stretches of country ?

At the moment it is rather fashionable to talk in terms of beef production. May I fasten attention on it for a moment as a specific example ? A week ago *The Times* published a Reuter message from Perth, reporting figures given by the Prime Minister for estimated increases in beef tonnages in North Australia and the likely periods required for full development, as indicated by the work of a Federal Cabinet sub-committee. Here they are : Northern Territory, Darwin area, 13,000 tons in 15 years ; Alice Springs 13,000 tons in 12 years ; Barkley Tableland area, 12,000 tons in 12 years ; Wyndham area, Western Australia 10,000 tons in 10 years. Thus we may expect 48,000 tons of export beef from these huge areas in from 10 to 15 years.

But if one applies a little simple arithmetic and distributes, say, 50,000 tons of beef amongst only 50,000,000 people, it is not difficult to arrive at a figure of only 2¼ lbs. per person per annum, with appropriate modification for the facts that babies don't eat beef and that ' beef ' includes bones.

250,000 square miles of country in the Northern Territory, the Kimberleys and the Queensland Gulf Regions are being mapped

by a Survey team for their land use possibilities. It looks and sounds well : but in such country there is apt to be something of anti-climax about the final figures when you are thinking in terms of the world's, or even only of Britain's millions.

The 'empty North' is a popular topic : but expectations must not be pitched too high. Indeed it may be that along the eastern side of the Continent, downwards to the Southern coast, greater possibilities of future beef production lie than in the much-canvassed North. Comprehensive surveys are in progress but no general conclusions are yet available.

Man does not live by beef alone. Indeed you are showing that he may live reasonably well, though with some grumbling, without much of it. Take a glance at dairy products, at mutton and lamb, pork and bacon, not forgetting cereal crops—all, as you know, available in useful but limited amounts. Big increases are desired in the yield figures for all of these.

There is, I admit, almost a general assumption that, on account of soil erosion and because of climatic and other environmental factors, Australia has broadly reached the limits of production of livestock and of agricultural crops. Many of us, however, are satisfied that this is unjustifiable pessimism. It may be that wheat production is at or near its limit : it has already spread into marginal areas where the gambling spirit (always strong with us) is called to its support. But in the various branches of the animal industry there need be less doubt about the over-all situation. Dr. John (now Lord) Boyd-Orr, after a visit to Australia somewhere about twenty years ago, prophesied that it could well become the stock farm of the Empire if its problems were properly handled. That great expansion is possible is still the confident belief of many people whose knowledge gives them a right to speak though it is as yet entirely speculative to fix a time for the realisation of the Boyd-Orr prophecy.

My purpose tonight is not to indulge the predictions of good or of ill but to indicate the primary, clamant need that exists for more knowledge of the type that can come only from first class scientific investigation on the most modern lines. Even leaving aside the always well-publicised call for study of plant and animal diseases and of pests, there are innumerable studies needed that some under neither heading but on which increased productivity will depend. I shall name a few.

1. We have endeavoured to establish both dairy and beef cattle industries on British breeds that were developed in and for a very different environment. The selection of strains capable of adaptation to new conditions and the introduction of special characteristics from Zebu and other types, give scope for first rate geneticists and breeders.

2. Our vaunted Merino sheep, too, present many challenges to breeders. The fertility of rams is markedly affected by high temperatures and by certain vitamin deficiencies. A definition of climatic and seasonal influences on the fertility of the ewe is needed if we are to raise a present lambing percentage of 65 to the known potential of 100 for existing breeds.

3. Perhaps dairying presents the biggest opening for application of scientific study to breeding and feeding, particularly in using protein supplements to make up for reduced nutritive value in many of our winter pastures. The protein problem, by the way, is full of fascinating biochemistry.

Over a big section of the dairying area of Queensland a cow averages only 120 lbs. of butter fat per annum. In this country your average is more than double that and, though we do not object to defeat in competition of any kind with the Motherland (being more or less accustomed to it), we would like to put up a better showing in dairying, for her sake as well as our own.

In pigmeat you know of the British Overseas Food Corporation's recent effort to overcome our lack of a cheap grain as the basis of pig feeding. Last Saturday, when scribbling these notes, I wrote at this point : ' 30,000 acres are expected to yield a million bushels of grain sorghum from certain areas in Central Queensland. Great work indeed, inciting a plan to sow a much greater acreage next year : but let us not forget that conditions were especially favourable this year and that there is what we sometimes call " beginner's luck " even in agriculture. Next year may tell a different story.'

Next day my attention was called to a *Times* cable from Brisbane dated August 21, which I had missed and which ran ' Damage caused by abnormal frosts has reduced the grain sorghum harvest on the Queensland British Food Corporation's farm at Peak Downs to 320,000 bushels as against an estimated yield of at least one million bushels.'

That, I am afraid, is the sort of thing that must just be accepted with philosophic resignation in Australia. It need not depress us unduly. One gets used to it.

Then in the South there are millions of acres with fairly reliable rainfall where absence of certain trace elements in the soil handicaps the pastoralist severely. In some cases, as in the Ninety Mile Desert region of South Australia, we now know of the significance of copper, zinc, cobalt and phosphate and can act accordingly. But elsewhere the

position is by no means so clear and it demands a study of both physical and chemical soil factors and of general plant metabolism, in which we are not as yet making much progress.

I shall not press on you a list of other examples of like kind. Believe me it is possible to draw up a long and stimulating list of challenges to every species of scientific man.

Before finishing with any Macedonian plea to come over and help us, may I just quote an example of quite a different line of work? My colleague and successor Dr. Ian Clunies Ross, Chairman of the Commonwealth Scientific and Industrial Research Organisation, has called attention to this interesting case. We make butter: may I add that four years after the end of the war we still ration ourselves in order that you may be made more obviously aware of this line of our production? The skim milk from this industry is used for little else than pig feed. As pig protein, only one-twelfth is returned for human nutrition and even that is an inferior food to skim milk powder with its excellent proteins and minerals.

Now in this skim milk, of which so little use is made, there is more first-class animal protein than there is in the whole of the beef and mutton production of the Commonwealth of Australia. This is assuming 200,000 tons of butter production, and that 23 per cent. of half a million tons of beef is protein and 18 per cent. of 275,000 tons of mutton and lamb. Surely this is a colossal waste in view of the world's protein shortage: some one should tackle it. There may be other hidden and equally surprising facts in our economy.

And now in the few remaining minutes may I make my chief point? The ratio World Food/World Population must be increased. I leave to others the problem of increasing it by reducing the denominator, or at any rate by stopping its present rate of increase. Maybe that is the outstandingly important step but at the moment we are concerned only with World Food. Complacency over this situation is impossible, but the main cause for anxiety as to Australia's part is not doubt of our ultimate capacity to grow more food but doubt of our ability to do it in the time available before disaster, major or minor, overtakes the world. It is the time factor that presses and oppresses. It may not be as serious and disconcerting elsewhere as it is in Australia: but I have failed if I have not conveyed to you the impression that any considerable contribution from that country in a relatively brief space of time will be achieved only if maximum vigour is displayed in first understanding, and then if possible removing, the handicaps besetting land industries.

And, rightly or wrongly, I believe that the efforts of economists and politicians, well directed and intelligent as they may be, will not suffice to meet the pressing need. It is the scientific men, working with all the aid that can be made available to them, that we must look for the needed help. They must be given the utmost freedom to determine and to follow their own tracks realising, as the President reminded us on Wednesday night, that 'the paths undiscerned of our eyes, the gods unseal.'

Who is to tackle these tasks? The prime responsibility, and a heavy moral responsibility it is, lies on Australia: but the plain fact is that we cannot of ourselves do this job effectively in the time available.

If the term 'British Commonwealth' implies anything surely it implies a recognition that we hold *in common* the wealth that is within our collective boundaries, and surely that in turn implies common responsibility to see that such wealth is made available to us all in a time of necessity such as this: available not only to ourselves either, but, if it be possible, also to the other human families to whom it has always been British practice to extend a helping hand.

I know that the demands on this country as a friend of all the world are very heavy: but the ability to aid in scientific effort and particularly in essential fundamental scientific enquiry, is here in abundance. Freer export of more of your best will merely stimulate the supply. There is no need for me to labour a point which is surely clear to all of us and I think is the outstanding message from Australia.

That particular part of our British group of nations will fail to pull its full potential weight in, say the next crucial 20 years, unless there is more of the team spirit amongst us all than we are displaying and practising at present.

Question Time

The last half-hour of the meeting was devoted to the answering of questions by a panel of experts consisting of Dr. J. Bronowski, Mr. G. V. Jacks and Sir Harold Tempany.

SEISMOLOGICAL INVESTIGATIONS

FIFTY-FOURTH REPORT of COMMITTEE on Seismological Investigations (Dr. R. STONELEY, F.R.S., *Chairman*; Lt.-Col. E. TILLOTSON, *Secretary*; Mr. E. F. BAXTER, Miss E. F. BELLAMY, Prof. P. G. H. BOSWELL, O.B.E., F.R.S., Mr. B. C. BROWNE, Dr. G. E. R. DEACON, F.R.S.; Dr. A. T. DOLLAR, Dr. A. E. M. GEDDES, O.B.E.; Prof. G. R. GOLDSBROUGH, C.B.E., F.R.S., Dr. WILFRED HALL, Mr. M. N. HILL, Dr. O. J. R. HOWARTH, O.B.E., Mr. J. S. HUGHES, Prof. H. JEFFREYS, F.R.S.; Mr. COSMO JOHNS, Mr. E. N. LAWRENCE, Dr. A. W. LEE, Prof. J. PROUDMAN, F.R.S.; Dr. A. O. RANKINE, O.B.E., F.R.S.; Rev. C. REY, S.J.; Dr. G. D. ROBINSON, Dr. F. J. SCRASE, Dr. H. SHAW, Mr. H. V. SHAW, Sir FRANK SMITH, G.B.E., K.C.B., Dr. J. M. STAGG, and Mr. P. L. WILLMORE.)

Personal.—The Committee deeply regret the death on December 26, 1948, at the age of 73 of the Rev. J. P. Rowland, S.J., whose name first appeared on the list of members of this Committee in 1926. Father Rowland was appointed assistant at Stonyhurst Observatory in 1919, and became its Director in 1932. His work at the Observatory included astronomical, magnetic and meteorological observations in addition to his seismological work, in the course of which he successfully located the epicentres of the North Sea earthquake of 1931, and the Wensleydale earthquake of 1933. His work on the latter was communicated in a paper to Section A in 1933. As a man, Father Rowland had great charm of manner, and in his priestly work he was a zealous and sympathetic helper of souls. It is indeed a privilege to have known him.

The Committee offers its congratulations to Prof. E. C. Bullard, F.R.S., on his appointment as Director of the National Physical Laboratory, to Prof. H. Jeffreys, F.R.S., on his award of a Royal Medal; to Mr. B. C. Browne on his appointment as Reader in Experimental Geophysics and Head of the Department of Geodesy and Geophysics in the University of Cambridge, and to Dr. R. Stoneley, F.R.S., on his appointment as Reader in Theoretical Geophysics at Cambridge.

MEETING OF COMMITTEE.—The Committee met on Thursday, September 9, 1948, in the School of Art, Brighton, at 2.15 P.M.

The Report of the Committee was discussed and approved.

The reprinting of the Jeffreys-Bullen Tables, and the recording of earthquakes at Downe were discussed, and it was agreed that the out-of-pocket expenses of running the seismographs at Downe might properly be borne by the Gray-Milne Fund. Of the balance shown, the sum of £400 has recently been invested temporarily in 2½% Defence Bonds.

THE GRAY-MILNE FUND

The main item of expenditure has been a contribution towards the running of the seismographs that were transferred from Oxford to Downe; as mentioned elsewhere, recording at Downe has had to be discontinued. The balance of the account has increased by over £43 during the year, but it is foreseeable that there may be considerable expenditure in the not very distant future.

Gray-Milne Fund

	£ s. d.		£ s. d.
Balance, July 1, 1948	474 10 7	Postage and Printing	4 9 7
Trust Income	80 14 10	Maintenance of Seismographs, Downe, Kent	27 19 11
		Maintenance of Shock Recorder	5 0 0
		Balance at Bank, June 30, 1949 522 15 11	
		Less cheque outstanding 5 0 0	
			517 15 11
	£555 5 5		£555 5 5

The International Seismological Summary

By Mr. J. S. Hughes and Prof. H. Jeffreys, F.R.S.

The printing of 1938 is now in hand. Certain changes in the form of presentation have been made. In future there will be three principal phases in the tabular matter instead of two. These will be, as before, P or PP or PKP in the column headed P ; S or SKS in the column headed S, and a third column which will take some other (preferably widely recorded) phase which may be any of those not accommodated in either of the other columns. It is intended to record *p*P or *s*P for appropriate earthquakes when these are given.

The traditional M is now omitted as being too vague to be taken seriously. The readings of this appear to differ as between various types of instruments and it seems probable that the apparent time is more dependent on method of recording than a definite property of the earthquake.

The work of preparation is still carried out at Kew Observatory through the hospitality of the Director, in premises placed at the disposal of the Committee in 1946. In addition to myself (Mr. J. S. Hughes) there are two full time members of the staff, Miss M. J. Hunter on the computing side and Mrs. Sanders as Secretary.

The preparation has been maintained by generous grants of £3000 from U.N.E.S.C.O. in each of the years 1947–48. The grant promised for 1949 is £1500. The balance in hand, together with this grant, will cover expenses for 1949, but if the previous income is not restored a difficult situation will arise in 1950.

Instruments

The instruments belonging to the Committee are located, as before, as follows :—

Milne-Shaw Seismograph, No.	1.	Downe, Kent
" " " "	3.	Edinburgh.
" " " "	4.	Downe, Kent.
" " " "	6.	Cape Town.
" " " "	27.	Perth, W.A.
" " " "	63.	Suva, Fiji.
Seconds Regulator Clock		Suva, Fiji.
Jagger Shock Recorder		Comrie.

Contrary to what was reported last year, recording at Edinburgh has continued, and records are now being read by Lt.-Col. E. Tillotson. Dr. O. J. R. Howarth ceased recording at Down House, Downe, during the year and the instruments are now in store there. Recording at Suva, Fiji, continues under the direction of Dr. D. R. Henderson of the Meteorological Office there. By arrangement with the New Zealand Meteorological Office, all records are being sent to the Dominion Observatory, Wellington, New Zealand, for interpretation and publication. Dr. R. C. Hayes now has all records from June 1943 to the end of 1948. It is intended to publish readings from 1948 onwards with the New Zealand Seismological Reports (E-Series Bulletins). Readings up to and including 1947 will be published at intervals as special bulletins. In spite of gaps in the recording, due to paper shortage and frequent clock trouble, a large number of earthquakes have been well recorded.

Dr. A. T. Dollar reports that the Jagger shock recorder at ' Dunira,' Comrie, Perthshire, has continued to function satisfactorily except for rare occasions on which the clock has stopped temporarily. The clock is inspected weekly, and adjusted when necessary, by Mr. J. McOwen, watchmaker, of Crieff, thanks to the generosity of Mr. W. G. Macbeth, owner of ' Dunira.' Mr. J. Clark has acted as operator since November 1944 in succession to Mr. J. White. Only the discs bearing records of tremors are fixed and preserved.

British Earthquakes

Dr. A. T. Dollar.

Has collected macroseismic data for the British Earthquakes of April 2, 1948, at Bethesda, Carnarvonshire, May 28, 1948, in East Anglia and May 31, 1948, at Ullapool, Ross-shire, in addition to some details of 7 subsidences, 2 landslides and an avalanche.

Mr. L. L. Alexander.

Has made a report on the East Anglian earth tremor which occurred on May 28, 1948 [*Meteorological Mag.*, Vol. 78, 1949, pp. 135–9]. See also report by Dr. A. W. Lee, Seismological Committee Report, 1948.

Dr. H. C. Versey reports:

'At about 5.35 P.M. on 23rd February, 1949, the Calder Valley was disturbed by an earth tremor which was felt over an area of about 150 square miles. The long axis of the elliptical disturbed area ran in an approximately east-west direction from Lightcliffe, east of Halifax to Waterfoot in Rossendale. Maximum intensity—Davison Scale 5—was experienced immediately north-east of Hebden Bridge. There is no mapped fault in this area with which the shock can be associated and the origin may perhaps be sought in the pre-Carboniferous basement rocks.'

Seismological Work of the Department of Geodesy and Geophysics, Cambridge

By Dr. R. Stoneley, F.R.S.

Experimental.—Until recently, the use of the method of 'seismic prospecting' for investigating the sea-floor has been restricted, on account of the technical difficulties, to water shallower than 100 fathoms. It was pointed out by Bullard that if the explosive charges were fired at a depth of only a few hundred feet, a sufficiently large fraction of the energy might be refracted into, and out of, the underlying rock to produce a recordable signal on a hydrophone at sea. Thanks to a grant received from the D.S.I.R. this method has been tested by Mr. M. N. Hill and the supposition has been confirmed. It was found that provided the hydrophone was suitably suspended at a sufficient depth below the surface, its sensitivity was nearly as great as that of a geophone lying on the bottom. The use of two ships was avoided by suspending the hydrophones from buoys containing amplifiers and radio-transmitters and by recording their output by a receiver in the ship from which the explosives were fired. At stations south of the Eddystone Lighthouse, the following results were obtained :—

Position : miles from Eddystone	5 miles, N.	5 miles, S.	10 miles, S.	15 miles, S.	20 miles, S.	30 miles, S.
Vel. in top layer .	9,700	9,760	8,880	7,400	6,230	8,190
Thickness of top Layer . .	390	860	1,440	420	490	270
Vel. in 2nd Layer	14,260	14,260	13,500	10,190	10,550	11,800
Thickness of top and 2nd layer .	—	—	—	3,120	3,020	3,350
Vel. in 3rd layer .	—	—	—	13,680	13,700	14,200
Thickness of top, 2nd and 3rd Layers . .	—	—	—	6,610	7,260 ?	—
Vel. in 4th layer .	—	—	—	18,000 ?	17,200 ?	—

Velocities in ft./sec. Thicknesses in feet.

Using seismographs of his own design, Mr. P. L. Willmore has been working at the Bernard Price Geophysical Institute, Johannesburg, on the 'rock bursts' that follow the detonation of charges in mines. In certain localities, presumably near active faults, quite small charges will sometimes initiate considerable earth movements which may reach a size comparable with a small earthquake. These may take place at times up to several hours after the detonation but always occur near the position of the explosion. Although their time of origin is not predictable, their position can be foretold with some certainty. Such 'rock bursts' are experienced in mines in Africa, where they have already been studied by workers

at the Bernard Price Geophysical Institute, Johannesburg. Mr. Willmore was invited to take the apparatus there to assist in the work. He has been able to extend his observations of the 'rock bursts' out to distances much greater than was originally contemplated. Excellent records have been obtained to 350 Km. and he is now trying to extend the line out to 450 Km.

THEORETICAL.—Dr. R. Stoneley has continued his work on the propagation of Love waves across Eurasia. It is doubtful how far a uniform two-layer structure of granite underlain by intermediate rock may be representative of the continental structure. On this hypothesis, the data point to a granitic layer some 30 Km. thick with only a very thin layer of intermediate rock below.

A theoretical investigation of the seismological implications of aeolotropy shows that there would not be the sharp distinction into compressional and distortional waves as in an isotropic elastic solid, and that there would be a difference in the time of arrival of SH and SV waves. A correction would be needed for the depth of focus and the thicknesses of the layers found in a reduction of the data on near earthquakes. Rayleigh waves can be propagated over the surface of a 'transversely isotropic' medium.

Mr. M. S. Longuet-Higgins is making a series of theoretical investigations into the relationship between microseisms and sea waves.

ASTRONOMICAL AND TIDAL EFFECTS OF A FLUID CORE

Prof. Harold Jeffreys, F.R.S.

The calculated value of the coefficient of the lunar nutation of the Earth's axis, according to the latest determinations is $9''\cdot2272 \pm 0''\cdot0008$. The observed values range from $9''\cdot207$ to $9''\cdot213$, and the discrepancy, though small, is quite definite. The calculated value is for a rigid Earth. There is good reason to suppose that it would not be appreciably affected by elasticity, so long as the whole Earth is taken as a solid, but fluidity of the core seems capable of making an appreciable reduction. The theory for a rigid shell and a fluid core has been treated by Kelvin, Hough, Poincaré and Lamb, who found that the amplitude of the lunar nutation would be less, and the period of the free nutation shorter, than for a rigid Earth with the same moments of inertia. On applying their results to modern data I find[1] that the theoretical coefficient of the lunar nutation is reduced to about $9''\cdot172$, which is decidedly less than the observed value, and the period of the free nutation would be reduced from 305 to about 270 days (the observed period being about 440 days). The explanation is connected with the fact that under changes of rotation of the shell the changes of angular momentum of a liquid core of small ellipticity may in different circumstances be much larger or much smaller than in a rigid core of the same dimensions.

The next step must be to include the effects of elasticity of the shell. It is known that elasticity lengthens the period of the free nutation and has little effect on the precession and lunar nutation in a solid body; and the theory of the associated elastic deformations is almost identical with that of tidal deformations. It has been supposed that fluidity of the core would represent the extreme case of elasticity, and consequently can be allowed for by taking the rigidity zero in the existing solutions; but it turns out that this procedure is incorrect, because the solutions derived for elasticity apply a statical theory to all internal movements, and in a fluid core the inertial terms can rise into importance. A new investigation has begun. It has been found that for semi-diurnal and fortnightly tides the motions in the shell are still given correctly if both rigidity and inertia in the core are neglected. This is not true for the diurnal group of tides or for the nutations, and investigations of these is proceeding.

Reappointment.

The Committee desires to be reappointed, without a grant.

[1] M.N.R.A.S. 108, 1948, 206–9.

NEWCASTLE MEETING
SECTIONAL TRANSACTIONS

Any references to publication supplied by authors will be found on page 385.

SECTION A
MATHEMATICS AND PHYSICS

September 1

Soil Physics.

Dr. R. K. Schofield.—*The physics of water retention in soil and water extraction by plant roots.*

Dr. H. L. Penman.—*The heat balance of the soil.*

Dr. Ezer Griffiths, F.R.S.—*Thermal characteristics of soil and their practical applications.*

Ultrasonics.

Dr. J. F. W. Bell.—*Absorption in air.*

Mr. J. D. Parbrook.—*Propagation in gases under pressure.*

Prof. A. Van Itterbeek.—*Measurements with ultrasonics in condensed gases at low temperatures.*

Dr. E. A. Alexander.—*Experiments on cavitation of sound in water.*

September 2

Some developments in astronomical instruments, Presidential Address by Sir Harold Spencer Jones, F.R.S.

Dr. D. S. Perfect.—*The new photographic zenith tube for the Royal Observatory.*

Dr. M. A. Ellison.—*The spectrohelioscope and some observations made with it.*

Dr. E. H. Linfoot.—*The Schmidt camera and some allied optical systems.*

September 5

Fundamental particles.

Dr. N. Kemmer.—*Present state of the theory of elementary particles.*

Dr. F. C. Frank.—*Recent investigations at Bristol University.*

Radio astronomy.

Mr. J. S. Hey.—*Radio frequency observations of the sun.*

Mr. F. G. Smith.—*Stellar astronomy at radio wavelengths.*

Dr. A. C. B. Lovell.—*Radio echo observations of meteors.*

September 6

Dr. R. Stoneley, F.R.S.—*Fifty-fourth report of Committee on Seismological Investigations.*

Geophysics.

Mr. B. C. Browne.—*Gravity survey in the British Isles.*

Mr. L. H. Tarrant.—*Recent geophysical surveys for oil in Southern England.*

Prof. J. Satterly.—*Geophysical researches in Canada.*

New developments in interferometry.

Dr. T. A. Littlefield.—*The reflecting echelon.*

Dr. W. J. Bates.—*Shearing interferometry.*

Mr. H. Barrell.—*Precision length measurements in terms of light waves.*

September 7

New optical methods for studying micro-structures.

Prof. S. Tolansky.—*Micro-topography of surfaces as revealed by multiple-beam interferometry.*

Mr. E. W. Taylor, C.B.E.—*The phase-contrast microscope.*

Mr. R. L. Drew.—*Recent developments of a reflecting microscope.*

SUB-SECTION A*
MATHEMATICS

September 1

Prof. W. W. Rogosinski.—*Volume and integral.*

Dr. L. F. Richardson, F.R.S.—*Successive approximations to the latent roots of a numerical matrix.*

Dr. E. F. Collingwood.—*The distribution of values of an analytic function.*

September 2

Prof. H. S. Ruse.—*Modern differential geometry.*

September 5

Dr. K. A. Hirsch.—*Theory of knots.*

September 6

Prof. E. Maitland Wright.—*Difference-differential equations.*

Dr. F. Smithies.—*Abstract analysis.*

SECTION B
CHEMISTRY

September 1

The influence of studies in combustion on the progress of chemistry, Presidential Address by Sir Alfred Egerton, F.R.S.

The propagation of flame.

Dr. J. W. Linnett.—*Measurement of flame speeds.*

Dr. A. G. Gaydon and Dr. H. G. Wolfhard.—*The propagation of flames at very low pressure and the role of diffusion in flame propagation.*

Prof. P. Lafitte and M. J. Elston.—*Domaines d'inflammabilité du méthane.*

Sir Alfred Egerton, F.R.S. and Mr. S. Thabet.—*Measurement of flame speeds in the neighbourhood of limits.*

Dr. D. T. A. Townend.—*The mechanism of flame propagation through media concerned with higher hydrocarbons and their derivatives: the two stage combustion process.*

September 2

The nitrogen cycle in nature.

Prof. G. R. Clemo, F.R.S.—*Introduction.*

Prof. Dr. A. I. Virtanen.—*Recent work on the utilisation of the nitrate ion by plants and its relation to the assimilation of the ammonium ion and molecular nitrogen.*

Prof. J. H. Quastel, F.R.S.—*Influence of organic nitrogen compounds, especially amino acids, in soil nitrification.*

Dr. G. R. Tristram.—*The amino acid-protein aspect of the problem.*

Dr. E. J. Hewitt.—*The importance of molybdenum in the nitrogen cycle and its relation to manganese.*

September 5

Fluorine : the element and some of its new compounds.
Mr. H. R. Leech.—*The production of elementary fluorine.*
Prof. H. J. Emeléus, F.R.S.—*Some recent advances in the chemistry of certain inorganic fluorine compounds.*
Prof. M. Stacey.—*Organic fluorine compounds.*

The combustion of carbon.
Prof. W. F. K. Wynne-Jones.—*Introduction.*
Mr. J. R. Arthur.—*Physico-chemical aspects of the combustion of solid carbonaceous fuels.*
Mr. G. W. Bridger.—*The oxidation of carbon and carbon monoxide.*
Dr. K. W. Sykes.—*Some recent views on the mechanism of the combustion of carbon.*

September 6

Chemistry and the food supply.
Dr. G. I. Higson.—*Introduction.*
Dr. E. M. Crowther.—*Chemicals and crop growth.*
Mr. S. W. Cheveley.—*Chemicals and weed control.*
Mr. D. D. Ogilvie.—*Chemicals and animal health.*
Mr. L. W. L. Cole.—*Chemicals and insect control.*
Dr. H. S. Hirst.—*Chemicals and grass conservation.*

SECTION C

Geology

September 1

Prof. H. G. A. Hickling, F.R.S.—*The geology of the Newcastle district.*
Dr. F. H. Stewart.—*The salt deposits of the Eskdale No. 2 boring, N.E. Yorkshire.*
Mr. W. Anderson.—*Pleistocene sea-levels in the British Isles at 190 and 140 ft. O.D.*
Dr. S. Tomkeieff.—*Geology in historical perspective.*

September 2

The geology of the ocean floor.
Prof. Hans Pettersson.—*The chronology of the ocean floor.*
Mr. B. C. Browne.—*Geophysical investigation of the floor of the ocean.*
Prof. Ph. H. Kuenen.—*The formation of the continental terrace.*
Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S.—*The floor of the Indian Ocean with special reference to the Arabian Sea area.*
Mr. C. D. Ovey.—*The significance of planktonic foraminifera as temperature indicators in ocean bottom cores.*
Dr. J. D. H. Wiseman.—*Manganese nodules from the Arabian Basin.*

September 5

Recent work on the Palaeozic rocks, Presidential Address by Prof. W. J. Pugh, O.B.E.
Prof. T. S. Westoll.—*The vertebrate faunas of the Carboniferous and Permian of the North of England.*
Dr. M. Macgregor and Mr. W. Manson.—*Recent developments in the Machrihanish coalfield near Campbelltown, Argyllshire.*
Dr. A. G. MacGregor.—*A comparison between crystals of glacier ice and sutured quartz crystals in Scottish psammitic granulites.*

September 6

The education of the professional geologist.
Prof. T. Neville George.
Mr. F. D. S. Richardson.
Dr. K. S. Sandford.

September 7

Mr. E. T. H. Whitten.—*A petrological study of the rock groups and intrusion phenomena of the Bunbeg area of Co. Donegal, Eire.*
Mr. W. G. Hardie.—*An occurrence of streaky migmatite and agmatite from Glen Coe.*
Prof. W. T. Gordon.—*History of the cutting of rock slices.*

SECTION D

Zoology

September 1

Zoology outside the laboratory, Presidential Address by Prof. A. C. Hardy, F.R.S.
Mr. A. J. A. Woodcock.—*North country naturalists.*
Prof. R. Dennell.—*An addition to observations on the feeding of* Amphioxus.
Mr. A. G. Lowndes.—*The meaning of the terms: Egg, Yolk and Fertilisation.*

Marine Ecology.
Dr. W. C. Hodgson.—*Echo-sounding and the pelagic fisheries.*
Dr. H. O. Bull.—*Fish and their environment.*
Mr. K. M. Rae, O.B.E.—*The continuous plankton recorder : a survey of the distribution of the subsurface plankton around the British Isles.*
Dr. D. Cushing.—*Vertical migration of plankton animals.*

September 2

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Field study centres.
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Aquatic locomotion.
Prof. J. Gray, C.B.E., F.R.S.—*Mechanical aspects of locomotion in animals.*
Mr. G. E. Gadd.—*Some hydrodynamical aspects of the steady swimming motions of slender fish.*
Dr. E. G. Richardson.—*Resistance of fish forms.*
Prof. L. C. Burrill.—*Frictional resistance.*

September 5

Genetics.
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Biological aspects of river pollution (Jointly with Section K).
Dr. B. A. Southgate.—*Effects of polluting liquids on rivers.*
Dr. F. T. K. Pentelow.—*Pollution and river fauna.*
Prof. W. H. Pearsall, F.R.S.—*Botanical problems in river pollution.*
Mr. Herbert Jones.—*Lead and zinc pollution in the rivers of N. Cardiganshire with special reference to the Rheidol.*

Insect flight and distribution.

Dr. C. B. Williams.—*Insect migration and insect distribution.*

Prof. A. C. Hardy, F.R.S.—*The aerial drift of insects across the North Sea.*

Dr. C. G. Johnson.—*Diurnal and nocturnal variation in the vertical distribution of insects, with special reference to Aphides.*

Mr. P. S. B. Digby.—*A wind tunnel for the study of insect flight.*

September 6

Salmon.

Dr. F. T. K. Pentelow.—*Commercial salmon fishing in England and Wales.*

Dr. J. W. Jones.—*The spawning behaviour of the Atlantic salmon* (Salmo salar L.).

Bird behaviour.

Mr. P. H. T. Hartley.—*Routines in bird life.*

Rev. E. A. Armstrong.—*Some aspects of the relationship between the pair bond and the breeding economy of birds.*

Mr. R. Carrick.—*The feeding reactions of starlings.*

Field evolutionary studies.

Dr. E. B. Ford, F.R.S.—*Selection in wild populations.*

Dr. H. B. Cott.—*Palatability and coloration of birds' eggs.*

Prof. V. C. Wynne-Edwards.—*Non-adaptive characters.*

Prof. G. C. Varley.—*Population ecology and adaptation.*

SECTION E

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Mr. A. E. Smailes.—*Early industrial settlement in N.E. England.*

Mr. J. W. House.—*The mobility of population in N.E. England since the early nineteenth century.*

Mr. R. M. Prothero.—*Settlement patterns in the Llyn Peninsula.*

Mr. M. R. G. Conzen.—*Newcastle upon Tyne.*

Dr. Alice Garnett.—*First results of climatological investigations in the High Peak.*

Mr. R. A. G. Savigear.—*Slope forms and slope formation in the Southern Pennines.*

September 2

The planning of land use, Presidential Address by Prof. L. Dudley Stamp, C.B.E.

Mr. T. W. Freeman.—*Rural Ireland in 1841.*

Miss W. M. Day.—*The relative permanence of political boundaries in India.*

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Prof. A. A. Miller.—*The climatic requirements of the major formations of natural vegetation.*

Mr. N. R. Wills.—*Irrigation and Australia's food supplies.*

Mr. J. M. Houston.—*Irrigation: a solution of agrarian problems in Spain.*

Mr. H. Bowen-Jones.—*Notes on the distinction between peasantry and small farming.*

Mr. D. B. Mather.—*Aspects of migration in the Anglo-Egyptian Sudan.*

Dr. L. F. Richardson, F.R.S.—*Mapping by cells of equal population with reference to culture-contact and world statistics of civil wars.*

September 6

Prof. H. C. Darby.—*Some sources for the regional geography of nineteenth-century England.*

Mr. R. T. Cornish.—*Aspects of regional geography in east central Sweden.*

Mr. S. J. Jones.—*The relationship between historical geography and regionalism as illustrated in California.*

Mr. J. P. Haughton.—*Local newspapers and the regional geographer.*

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Dr. W. B. Fisher.—*The climate of the eastern Mediterranean and monsoonal circulations.*

Mr. H. R. Wilkinson.—*Ethnographic maps of Macedonia.*

SECTION F

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September 1

Mr. E. Allen.—*The economic aspect of the building of a new town in South East Durham.*

Mr. G. A. Petch.—*A Darlington Quaker capitalist of the early nineteenth century.*

September 2

Economics; yesterday and tomorrow, Presidential Address by Sir Alexander Gray, C.B.E.

Mr. L. C. Wright.—*Scottish Chartism and its economic background.*

Mr. R. M. Shone, C.B.E.—*Planning and competition in industry.*

September 5

Mr. J. D. M. Bell.—*Trends in the industrial distribution of Trade Union membership, 1911–1947.*

Mr. G. Clayton.—*Investment of life insurance funds.*

The present position of the coal industry of Great Britain. (Jointly with Section B and C).

Prof. A. Beacham.

Dr. I. G. C. Dryden.

Prof. H. G. A. Hickling, F.R.S.

Mr. W. MacLean.

September 6

Dr. K. G. Fenelon.—*Britain's food supply.*

Rt. Hon. Lord Beveridge, K.C.B.—*The contribution of price study to economic history.*

Mr. S. A. Sadler Forster.—*Industrial estates in a development area.*

SECTION G

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Dr. R. W. Sillars.—*Insulating and semi-conducting materials.*

Dr. F. Brailsford.—*Magnetic materials for electrical power plant.*

Dr. R. W. Bailey, F.R.S.—*Metals for high duty.*

Mr. Haswell Alder, Mr. Arthur Walker and Mr. E. L. J. Potts.—*Yield pillar technique in deep coal mining.*

Prof. H. Cotton.—*Lighting of the coal face.*

September 2

Ground subsidence.
Mr. E. L. J. Potts.—*Ground subsidence from mining.*
Dr. T. Robertson.—*Geological aspects.*
Dr. J. Charlesworth.—*Legal aspects.*
Mr. George Raw.—*A general view of the problem.*
Prof. L. C. Burrill.—*Marine propulsion—the designer's problem.*

September 5

Bridging the gap between science and industry, Presidential Address by Sir Arthur P. M. Fleming, C.B.E.
Sir Andrew McCance, F.R.S.
Sir Henry Tizard, G.C.B., F.R.S.
Dr. A. L. Whiteley.—*Electronics.*

September 6

Papers by young engineers.
Mr. E. Murphy.—*Recent developments in use of coke.*
Mr. A. Chisholm.—*Settlement of structures on clay foundations.*
Mr. H. Watson.—*Propulsion of ships by jets.*
Mr. G. Snowball.—*Electrical methods of inducing and detecting vibrations.*
Dr. J. C. Weston.—*Heating research for houses.*

SECTION H

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Miss N. Newbigin.—*Northumbrian rock-carvings.*
Dr. I. A. Richmond.—*The tactics of Hadrian's Wall.*

September 2

Mr. T. W. Bagshawe.—*A plea for a museum of English life and traditions.*
Mr. T. Wake.—*Agricultural bygones of the North East.*
Dr. Arthur Geddes.—*The farm labour-team in the southern counties of Scotland : its society and its instability* (' *semi-nomadism* '), c. *1800–1939.*
Field study and research centres.
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Mr. M. T. Fosbrook.—*Rock-paintings in Kondoa district, Tanganyika.*
Mr. A. J. Arkell.—*The Khartoum Neolithic.*

September 5

Major E. R. Collins.—*Lower Palaeolithic implements in northern England.*
Mr. A. Leslie Armstrong.—*Recent excavations in Palaeolithic caves and shelters of the Creswell Region.*
Dr. K. P. Oakley.—*Further applications of the fluorine test.*
Dr. Robert Broom, F.R.S.—*Note on the Piltdown skulls.*

September 6

Dr. Margaret Murray.—*The Divine King in England.*
Mrs. N. K. Chadwick.—*Dreams in early European literature.*
Prof. E. O. James.—*The function of religion in Society.*
Miss S. R. Burstein.—*Old age in England from mediaeval times.*
Mr. D. F. Roberts.—*The racial history of Britain.*

SECTION I

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Adolescent nutrition.
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Dr. T. L. Scott.—*Nutrition in Public School boys.*
Dr. R. Passmore.—*Dietary habits and nutrition in university students.*
Dr. R. E. Smith.—*Nutrition in a school population and its relation to the incidence of infection.*

September 2

The relation of brain to mind. (Jointly with Section J.)
Prof. G. Jefferson, C.B.E., F.R.S.—*Introduction.*
Prof. A. D. Ritchie.—*The relation of body and mind.*
Mr. O. L. Zangwill.—*Disorders of visual space perception in cases of brain injury.*
Prof. A. Kennedy.—*Aspects of the brain-mind relationship revealed by the study of organic disorders.*

September 5

The cell.
Presidential Address by Prof. R. A. Peters, M.C., F.R.S.
Dr. R. Barer.—*New methods of microscopy in the study of cell structure.*
Prof. J. N. Davidson.—*Chemical aspects.*
Prof. A. C. Frazer.—*Lipoproteins in cell structure and function.*
Dr. Swann.—*The structure in relation to sea urchin eggs.*
Dr. G. H. Bourne.—*Mitochondria.*

September 6

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Dr. D. P. Cuthbertson.—*Introduction.*
Dr. A. T. Phillipson.—*General consideration of conditions.*
Mr. F. Baker.—*Food structure and microbial interrelations.*
Dr. I. Macdonald.—*The nature of dietary protein in relation to its utilisation by the ruminant.*
Dr. K. M. Henry, Dr. S. K. Kon and Mr. J. W. G. Porter.—*Vitamin synthesis in relation to requirements.*
Dr. J. Tosic.—*Integration of microbial activities from the bio-chemical standpoint.*

September 7

Folic acid, vitamin B_{12} and anaemia.
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SECTION J

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Sociological investigations in the planning of Aycliffe.
Dr. Dennis Chapman.—*Social planning for a new town.*
Mr. G. G. Baines.—*Some effects of social planning on design.*
The nature of the minds factors, Presidential Address by Sir Godfrey Thomson.

Dr. F. M. Earle.—*Use of the Duplex Tests in selection for secondary education.*
Mr. Z. Swanson.—*Further investigation of the Moray House space test.*
Mr. S. Wiseman.—*The use of English composition in the selection of children for grammar schools.*

September 2

The relation of brain to mind.
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Miss A. Crawford.—*The Ishihara Test and the frequency of colour weakness.*
Dr. R. W. Pickford.—*The validity of the Ishihara Test for colour blindness.*
Mr. R. R. Hetherington.—*The Snellen Chart as a test of visual acuity.*
Mr. W. A. McElroy.—*An experimental study of the relationship between hedonic tone and conscious memory.*

September 5

Psychological studies of the quality of the population.
Dr. P. E. Vernon.—*Introduction.*
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Mr. J. Maxwell.—*Scottish Mental Survey (1932 and 1947).*
Mr. D. Kennedy Fraser.—*Individual testing of a 'six-day' sample.*

September 6

Human problems in the design of machinery and working methods.
Dr. N. H. Mackworth.
Dr. C. B. Frisby.
Wing-Cdr. H. P. Ruffell Smith.
Psychological procedures in selection of factory operatives.
Mr. W. S. Porteous.
Mr. R. F. Garside.
Mr. J. C. Raven.—*The comparative assessment of personality.*

September 7

Psychology and the teacher.
Mr. J. Lumsden.—*Psychology and the psychologist in the service of education.*
Miss C. M. McCallum.—*Child guidance service.*
Prof. E. A. Peel.—*Objective research into educational problems.*

SECTION K

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September 1

Dr. J. Feldmann.—*La végétation marine de la Mediterranée comparée a celle de la Manche.*
Dr. E. M. Burrows.—*A biological study of some members of the British* Fucaceae.
The utilisation of macroscopic marine algae through the ages, Presidential Address by Prof. Lily Newton.

September 2

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Dr. W. B. Turrill.—*Character combinations and distribution in the genus* Fritillaria *and allied genera.*
Mr. Peter Bell.—*Phylogenetic trends in the genus* Elaphoglossum.
Dr. Yolande Massey.—*Species problems in the blackberry.*
Dr. C. H. Gimingham, Mrs. E. T. Robertson and Miss B. Whinfield.—*The maritime ecology of St. Cyrus, Kincardineshire.*
Prof. A. R. Clapham.—*The Teesdale flora.*

Field study and research centres. (Jointly with Sections C, D, E and H.)
Mr. E. A. R. Ennion.—*Flatford Mill.*
Mr. J. H. Barrett.—*Dale Fort.*
Mr. G. E. Hutchings.—*Juniper Hall.*
Mr. P. T. Holmes.—*Malham Tarn.*
Mr. G. T. Goodman.—*Preliminary investigation of the flora of Skokholm.*
Mr. P. J. Conder.—*Preliminary investigation of the avifauna of Skokholm.*

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Biological aspects of river pollution.
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Dr. P. T. Thomas.—*The differential action of certain external agents on the nucleus and cytoplasm.*
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Mr. T. C. Carter.—*The induction of mutations in small mammals by radiations.*
Dr. Charlotte Auerbach.—*The production of mutations by chemical means.*

Forests and Man.
See entry under Sub-section K*.
Dr. Helen Porter.—*Some problems of enzyme action in cereals.*
Mr. W. W. Schwabe.—*Photoperiodism in the Chrysanthemum.*
Mr. C. L. Mer.—*Light response of the mesocotyl of oats.*
Dr. H. G. Wager.—*An interpretation of the changes in rate of production of carbon dioxide of peas as a result of wilting.*
Dr. L. W. Mapson.—*Factors affecting the synthesis of ascorbic acid in cress.*
Mr. H. Tristram.—*Some factors affecting the growth of soil bacteria.*
Prof. F. E. Fritsch, F.R.S.—*Algae and calcareous rocks.*

September 6

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Dr. Ernest Gäumann.—*The physiological problem of pathological wilting in plants.*
Prof. Meirion Thomas, F.R.S.—*Some effects of carbon dioxide on sugar breakdown in higher plants.*
Dr. W. E. Foster.—*Zymasis in water plants.*
Prof. D. Thoday, F.R.S.—*The succulent habit.*
Miss B. M. Gowdridge.—*The effect of a humid atmosphere on leaves of* Kleinia radicans.
Mr. J. G. Boswell.—*Some observations on the metabolism of tissue slices.*
Dr. R. Scott Russell.—*Radioactive phosphorus as a tracer in plant nutritional studies.*

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Miss Sheila M. Lodge.—*A study in periodicity in marine algae.*
Mr. W. T. Mathias.—*Hitherto undescribed stages in the life-history of* Chordaria flagelliformis.
Dr. A. A. Aleem.—*The zonation of littoral diatoms.*
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Dr. Karl Wilson.—*Visible fibrils in the cell-wall of* Valonia.
Miss Betty Moss.—*Variations in chemical composition during development of* Himanthalia lorea.
Miss Margaret Naylor.—*The anatomical structure of* Himanthalia lorea.
Dr. S. Williams.—*The occurrence of* Cryptothallus mirabilis *Malmb. in Scotland.*

SUB-SECTION K*

Forestry

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Problems of afforestation of moorlands.
Mr. J. Fraser.—*The development of methods of preparation of site for planting on moorlands.*
Mr. J. A. B. Macdonald.—*Drainage problems in moorland afforestation.*
Mr. J. W. L. Zehetmayr.—*The use of fertilisers in moorland afforestation.*
Dr. L. Leyton.—*Some fundamental problems in the afforestation of moorlands.*

September 2

Mr. P. F. Wareing.—*Factors controlling the annual duration of growth in trees.*
Mr. P. Harris.—*Sawmilling research.*
Dr. W. P. K. Findlay.—*Prevention of decay in newly felled timber.*

September 5

Rt. Hon. Lord Bolton.—*The place of hardwoods in Pennine forestry.*
The future of our new forests, Chairman's Address by Prof. H. G. Champion, C.I.E.
Mr. W. E. Hiley.—*The economics of Britain's forestry programme.*
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Dr. Kathleen B. Blackburn.—*The prehistoric forests of the north of England.*
Dr. Verona Conway.—*Forest destruction in prehistoric and mediaeval times.*
Dr. Frank Darling.—*The history of the Scottish forests.*
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SECTION L

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September 2

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Prof. A. F. Burstall.
Mr. K. R. Evans and Mr. D. J. Crowther.
Objectives in education of colonial peoples.
Mr. W. E. F. Ward, C.M.G.
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September 5

Curriculum of the secondary modern school.
Mr. F. A. Crofts.
Miss A. MacArthur.

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Mr. L. T. Taylor.—*Administrative problems of head teachers.*
Dr. P. F. R. Venables.—*Education in administration.*
Science in adult education.
Discussion on Report opened by Mr. W. O. Lester Smith, C.B.E.

September 7

The primary school in the new situation.
Miss N. Catty.—*Reshaping the primary school.*
Mr. F. Barraclough.—*Public policy.*

SECTION M

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Dr. T. I. Davies.—*Education and the rural community.*

September 2

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Prof. Alun Roberts.—*The historical factor in the study of agricultural ecology.*
Prof. J. E. Nichols.—*Ecological aspects of livestock production and husbandry.*
Prof. K. W. Braid.—*Some ecological problems of hill farms.*
Dr. Mary D. Glynne.—*Ecology of fungal footrots of wheat.*
Dr. Frank Darling.—*Agricultural ecology as a branch of science.*

September 5

The plane of nutrition of livestock in relation to resources.
Mr. R. W. Pomeroy.—*The plane of nutrition of pigs and sheep in relation to resources.*
Dr. S. Bartlett.—*The plane of nutrition in milk production.*
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Prof. M. M. Cooper.—*Development of domestic beef production.*

September 6

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Forestry and hill farming. (Jointly with Section K*.)
Rt. Hon. Lord Robinson, O.B.E.—*The utilization of hill land.*
Prof. R. W. Wheldon.—*The agricultural importance of hill land.*
Mr. A. P. Long, O.B.E.—*Some practical aspects of afforestation in the hill country of Britain.*
Mr. D. H. Dinsdale.—*Economic considerations relevant to the retention of hill land in agricultural use.*
Prof. G. W. Robinson, C.B.E., F.R.S.—*Forestry versus grazing in upland areas.*

REFERENCES TO PUBLICATION OF COMMUNICATIONS TO THE SECTIONS

AND OTHER REFERENCES SUPPLIED BY AUTHORS

(As at Dec. 22, 1949)

The titles of discussions, or the name of readers of papers in the Sections, as to which publication notes have been supplied, are given below in alphabetical order under each Section.

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Phillipson, Dr. A. T. Cf. 1944 *Biol. Rev., Camb. Phil. Soc.*, **19**, 41.

Passmore, Dr. R. Cf. ' Studies of the diet of students at Edinburgh University,' 1949 *Brit. J. Social Med.*, **3**, 10.

Scott, Dr. T. L. *Education*, Oct. 14, 1949.

Smith, Dr. E. L. To appear in *Proc. Roy. Soc.*, B. Cf. ' Purification of anti-pernicious anaemia factors from liver,' 1948 *Nature*, **161**, 638 ; ' Paper chromatography of the vitamin B_{12} group of factors,' 1949 *Biochem J.*, **45**, Proc. xii.

Section J

Human problems in the design of machinery and working methods, 1949 *Nature*, **164**, 982.

Psychological studies of the quality of the population, 1949 *Nature*, **164**, 598.

Psychology and the teacher, 1949 *Nature*, **164**, 609.

Chapman, Dr. D. *Report of Town & Country Planning Summer School*, 1948.

Frisby, Dr. C. B. To appear in *Occupational Psychology*.

McCallum, Miss C. M. To appear in *Brit. J. Educ. Psych.*

Peel, Prof. E. A. To appear in *J. Inst. of Education, Durham University*, **1**, No. 2.

Porteous, W. S. Cf. ' Recent developments in industrial selection techniques,' *J. Mental Science*, Jan. 1950.

Pickford, Dr. R. W. To appear in *Brit. J. Psychology*. Cf. 1944 *Nature*, **153**, 656.

Wiseman, S. 1949 *Brit. J. Educ. Psych.*, **19**, 200–209.

Section K

Artificial production of mutations, 1949 *Nature*, **164**, 731.

Aleem, Dr. A. A. To appear in *J. of Ecol.* as ' Distribution and ecology of British marine littoral diatoms.'

Auerbach, Dr. C. Cf. ' The chemical production of mutations,' 1947 *Science*, **105**, 243.

Bell, P. R. Expected to appear in *Ann. of Botany*.

Burrows, Dr. E. M. Expected to appear in *J. Mar. Biol. Assn.*

Gimingham, Dr. C. H. *et al.* Expected to appear in *Trans. Bot. Soc. Edinburgh*.

Lodge, Miss S. M. Expected to appear in *J. Ecol.*

Mapson, Dr. L. W. Cf. ' Factors affecting synthesis of ascorbic acid in cress seedlings,' 1947 *Biochem. J.*, **41**, 197 ; 1949 *Ibid.*, **45**, 171.

Massey, Dr. Y. Expected to appear in *New Phytologist*.

Naylor, Miss M. Expected to appear in *Ann. of Botany*.

Parke, Dr. Mary. To appear in *J. Mar. Biol. Assoc.* Cf. 1948 *J. Mar. Biol. Assoc.*, **27**, 651–709.

Porter, Dr. H. K. Expected to appear 1949 *Biochem. J.* **45**, No. 4. Cf. ' Some factors concerned in the process of starch storage in the barley grain,' 1945 *Nature*, **156**, 70.

Russell, Dr. R. S. To appear in *J. Exp. Bot.* Cf. ' The use of radioactive phosphorus in plant nutritional studies,' 1949 *Nature*, **163**, 71.

SUB-SECTION K*

Forests and man, 1949 *Nature*, **164**, 687.

Conway, Dr. V. M. Cf. ' Ringinglow bog, near Sheffield : I, Historical,' 1947 *J. Ecol.*, **34**, 149.

Findlay, Dr. W. P. K. 1949 *Timber Trades Journal*, **190**, 1719–1720.

Gorrie, R. M. *Agriculture Pakistan*, Sept. 1949.

Wareing, P. F. Cf. ' Photoperiodism in woody species,' 1949 *Forestry*, **22**, 211–221 ; ' Photoperiodic control and leaf growth—cambial activity in *pinus sylvestris*,' 1949 *Nature*, **163**, 770.

SECTION L

Objectives in the education of Colonial peoples, 1949 *Nature*, **164**, 526,

Science in adult education, 1949 *Nature*, **164**, 608.

Technology and the humanities, 1949 *Nature*, **164**, 566.

Barraclough, F. *Education*, Sept. 16, 1949 ; *The Schoolmaster*, Sept. 15, 1949.

Crofts, F. A. *Education*, Oct. 14, 1949.

Crowther, D. J., and Evans, K. R. *Education*, Dec. 9, 1949.

MacArthur, Miss A. M. To appear in *Education*.

Taylor, L. T. *Education*, Sept. 23, 1949.

Venables, Dr. P. F. R. *Education*, Sept. 23, 1949, pp. 497–502. Cf. ' Administrator and teacher,' *Education*, Dec. 10, 1948, pp. 1012–1014.

SECTION M

Forestry and hill farming, 1949 *Nature*, **164**, 640.

Plane of nutrition of livestock in relation to resources, 1949 *Nature*, **164**, 641.

Cooper, Prof. M. M. Expected to appear in *Scottish J. of Agriculture*.

Dinsdale, D. H. Cf. ' Hill sheep farming,' *Proc. Agric. Economics Soc.*, **8**, No. 4.

Glynne, Dr. M. D. *Farmer and Stockbreeder*, Sept. 6, 1949. Cf. ' Effect of previous crops on the incidence of eyespot on winter wheat,' 1949 *Ann. App. Biol.*, **36**, 341–351.

RESEARCH COMMITTEES, 1949–50

Grants of money, if any, from the Association for expenses connected with researches are indicated in heavy type.

SECTION A.—MATHEMATICS AND PHYSICS.

Seismological investigations.—Dr. R. Stoneley, F.R.S. (*Chairman*), Lt.-Col. E. Tillotson (*Secretary*), Mr. E. F. Baxter, Miss E. F. Bellamy, Prof. P. G. H. Boswell, O.B.E., F.R.S., Mr. B. C. Browne, Dr. E. C. Bullard, F.R.S., Dr. G. E. R. Deacon, F.R.S., Dr. A. T. J. Dollar, Dr. A. E. M. Geddes, O.B.E., Prof. G. R. Goldsbrough, C.B.E., F.R.S., Dr. Wilfred Hall, Mr. M. N. Hill, Dr. O. J. R. Howarth, O.B.E., Mr. J. S. Hughes, Prof. H. Jeffreys, F.R.S., Mr. Cosmo Johns, Mr. E. N. Lawrence, Dr. A. W. Lee, Prof. J. Proudman, F.R.S., Dr. A. O. Rankine, O.B.E., F.R.S., Rev. C. Rey, S.J., Dr. G. D. Robinson, Dr. H. Shaw, Mr. H. V. Shaw, Sir Frank Smith, G.C.B., G.B.E., F.R.S., Mr. P. L. Willmore.

SECTION C.—GEOLOGY.

To excavate critical geological sections in Great Britain.—Prof. W. T. Gordon (*Chairman*), Prof. W. G. Fearnsides, F.R.S. (*Secretary*), Sir Edward Bailey, M.C., F.R.S., Mr. J. L. Begg, Mr. W. S. Bisat, F.R.S., Prof. P. G. H. Boswell, O.B.E., F.R.S., Prof. A. H. Cox, Mr. E. E. L. Dixon, Dr. Gertrude Elles, M.B.E., Prof. H. L. Hawkins, F.R.S., Prof. G. Hickling, F.R.S., Dr. R. G. S. Hudson, Prof. V. C. Illing, F.R.S., Prof. O. T. Jones, F.R.S., Dr. Murray Macgregor, Prof. L. R. Moore, Dr. F. J. North, Dr. W. E. Swinton, Dr. Mabel E. Tomlinson, Dr. F. S. Wallis, Prof. D. M. S. Watson, F.R.S., Prof. T. S. Westoll, Mr. T. H. Whitehead, Prof. W. F. Whittard, Prof. S. W. Wooldridge. **£20.**

To consider and report on questions affecting the teaching of geology in schools.—Dr. A. E. Trueman, F.R.S. (*Chairman*), Dr. Mabel E. Tomlinson (*Secretary*), Miss M. A. Arber, Prof. A. H. Cox, Mr. J. Davies, Miss Gaynor Evans, Prof. W. G. Fearnsides, F.R.S., Prof. T. N. George, Prof. G. Hickling, F.R.S., Prof. D. E. Innes, Prof. L. R. Moore, Prof. W. J. Pugh, Dr. K. S. Sandford, Dr. H. Dighton Thomas, Dr. A. K. Wells, Prof. A. Wood.

The collection, preservation, and systematic registration of photographs of geological interest.—Prof. H. L. Hawkins, F.R.S. (*Chairman*), Mr. G. S. Sweeting (*Secretary*), Mr. H. Ashley, Dr. A. J. Bull, Mr. G. Macdonald Davies, Dr. A. G. MacGregor, Dr. F. J. North, Mr. J. Ranson, Prof. W. F. Whittard.

SECTION D.—ZOOLOGY.

To nominate competent naturalists to perform definite pieces of work at the Marine Laboratory, Plymouth. —Prof. H. G. Jackson (*Chairman*), Prof. J. E. Harris (*Secretary*), Prof. H. Munro Fox, F.R.S., Dr. C. F. A. Pantin, F.R.S., Mr. F. S. Russell, F.R.S., Prof. C. M. Yonge, F.R.S. **£50.**

To co-operate with other sections interested, and with the Zoological Society for the purpose of obtaining support for the Zoological Record.—Mr. M. A. C. Hinton, F.R.S. (*Chairman*), Dr. J. P. Harding (*Secretary*), Dr. I. Gordon, Mr. N. B. Kinnear, Dr. O. W. Richards. **£50.**

SECTIONS D, K.—ZOOLOGY, BOTANY

To aid competent investigators selected by the committee to carry out definite pieces of work at the Freshwater Biological Station, Wray Castle, Windermere.—Prof. F. E. Fritsch, F.R.S. (*Chairman*), Mr. H. C. Gilson (*Secretary*), Prof. P. A. Buxton, F.R.S., Dr. G. S. Carter, Miss P. M. Jenkin, Prof. W. H. Pearsall, F.R.S. **£50.**

To aid competent investigators selected by the committee to carry on definite pieces of work at the Zoological Station at Naples.—Dr. C. F. A. Pantin, F.R.S. (*Chairman and Secretary*), Prof. H. Munro Fox, F.R.S., Prof. F. E. Fritsch, F.R.S., Prof. A. C. Hardy, F.R.S., Dr. Margery Knight, Prof. Lily Newton, Prof. J. Z. Young, F.R.S. **£50.**

Co-ordinating committee for Cytology and Genetics.—Prof. R. A. Fisher, F.R.S. (*Chairman*), Dr. J. L. Crosby (*Secretary*), Dr. D. G. Catcheside, Prof. F. A. E. Crew, F.R.S., Dr. C. D. Darlington, F.R.S., Dr. E. B. Ford, F.R.S., Dr. J. Hammond, F.R.S., Prof. T. J. Jenkin, Dr. P. C. Koller, Prof. I. Manton, Prof. K. Mather, F.R.S., Prof. L. S. Penrose, Dr. G. Pontecorvo, Dr. R. R. Race, Dr. P. T. Thomas, Dr. W. B. Turrill, Prof. C. H. Waddington, F.R.S. **£5.**

SECTION E.—GEOGRAPHY.

To collect records of the revival of Geography in the British Isles dating from the later years of the nineteenth century.—Mr. J. N. L. Baker (*Chairman*), Mr. T. W. Freeman (*Secretary*), Prof. H. C. Darby, Prof. W. G. East, Dr. A. Geddes, Dr. O. J. R. Howarth, O.B.E., Prof. D. L. Linton. **£5.**

To promote and co-ordinate studies in the British Isles of Urban geography.—Prof. C. B. Fawcett (*Chairman*), Mr. A. E. Smailes (*Secretary*), Mr. M. R. G. Conzen, Dr. A. Geddes, Mr. E. W. Gilbert, Mr. J. P. Haughton, Dr. E. C. Willatts, Mr. M. J. Wise. **£3.**

To collect and record information on demography and seasonal activities in relation to environment in Inter-Tropical Africa.—Prof. A. G. Ogilvie, O.B.E. (*Chairman*), Mr. R. W. Steel (*Secretary*), Dr. R. J. Harrison Church, Prof. F. Debenham, O.B.E., Prof. C. Daryll Forde, Mr. D. B. Mather. **£5.**

SECTION H.—ANTHROPOLOGY.

To co-operate with the Torquay Natural History Society in investigating Kents Cavern.—Mr. M. C. Burkitt (*Chairman*), Prof. V. G. Childe (*Secretary*), Mr. A. L. Armstrong, Prof. D. A. E. Garrod, Mr. A. G. Madan, Dr. K. P. Oakley, Prof. F. E. Zeuner. **£10.**

To co-operate with a committee of the Royal Anthropological Institute in the exploration of caves in the Derbyshire district.—Mr. M. C. Burkitt (*Chairman*), Mr. A. Leslie Armstrong (*Secretary*), Dr. Arthur Court, Prof. H. J. Fleure, F.R.S., Prof. D. A. E. Garrod, Mr. W. H. Hanbury, Dr. J. Wilfred Jackson, Mr. R. U. Sayce.

To report on the composition of ancient metal objects.—Prof. V. Gordon Childe (*Chairman*), Dr. C. H. Desch, F.R.S. (*Secretary*), Dr. W. G. Broomhead, Mr. H. H. Coghlan, Prof. H. J. Fleure, F.R.S., Prof. C. F. C. Hawkes, Prof. M. E. L. Mallowan, Mr. H. Maryon.

To carry out research among the Ainu of Japan.—Mrs. C. G. Seligman (*Chairman and Secretary*), Rt. Hon. Lord Raglan, Mr. Arthur Waley.

To reinvestigate the Bury St. Edmunds skull site.—Mr. M. C. Burkitt (*Chairman*), Dr. K. P. Oakley (*Secretary*), Mr. A. Leslie Armstrong, Mr. D. F. W. Baden-Powell, Prof. V. Gordon Childe. **£15.**

To study the history and ethnology of sheep farming and farmers in the Cheviots.—Mr. R. U. Sayce (*Chairman and Secretary*), Mr. A. Leslie Armstrong, Mr. M. C. Burkitt, Dr. I. A. Richmond, Dr. R. N. Salaman, F.R.S., Dr. R. K. Schofield. **£25.**

SECTION K.—BOTANY.

To consider the position of biology and rural science in the school curriculum and matters relating thereto.—Prof. L. J. Audus (*Chairman*), Dr. L. M. J. Kramer (*Secretary*), Mr. W. J. Heasman, Prof. C. T. Ingold. **£5.**

MEMBERSHIP OF COUNCIL

Professor J. D. Bernal

On November 4, 1949, under discretion given by the General Committee on August 31, 1949, the Council of the British Association decided not to elect Professor J. D. Bernal to the seat on Council which had been left vacant by the General Committee. In response to requests from members of the Association, the Council decided on December 2 to publish in the Association's Journal the documents on which their decision was taken. The following are the relevant papers.

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1. *Extract from Minutes of Council, August* 31, 1949. (*Minute* 5).

The Council's report contained recommendations for the appointment of ordinary members of Council for the ensuing year, and the question was raised whether the name of Professor Bernal (which was included in the list) should go forward to the General Committee, in view of press reports of a speech made in Moscow. It was generally agreed that, if the remarks made by Professor Bernal were correctly reported, they contained an expression of views on science in Britain to which the Council, representing the Association, could not subscribe. It would, however, be wrong to assume that the press reports were correct, and it was accordingly resolved :

That the Council invite Professor Bernal to substantiate or otherwise, the statements represented in the press to have been made by him in Moscow on August 27, and that until that reply were received the nomination of Professor Bernal for membership of the Council should not be proceeded with and that a vacancy on the Council be maintained.

The President and General Officers were authorised to issue a press statement after the meeting of the General Committee, if it appeared desirable to do so in order to prevent wrong interpretations being put upon the action proposed.

2. *Copy of a letter to Professor Bernal.*

Burlington House, W.1.
9th September, 1949.

Prof. J. D. Bernal, F.R.S.

Dear Sir—I enclose a copy of the Minutes of the Meeting of Council at Newcastle on

August 31 (confirmed at a second meeting on September 7).

I have been asked to draw your attention to Minute 5 and to invite your comment on it.

The resolution of Council was reported to the General Committee on August 31 and was approved with only two members dissenting.

A short press statement was also issued, with the object of making it clear that your reappointment as a member of Council had been deferred until you had had an opportunity of saying whether you had been correctly reported in the press.

Before passing their resolution, the Council recognised in discussion that it was necessary to distinguish between political statements of members of the Council (which did not concern the Council), and statements on the direction and use of science in this country (on which the Council, representing the Association, might be expected to have views). The press reports of your speech in Moscow contained statements on the direction and use of science to which the Council could not subscribe.

Yours faithfully,
D. N. Lowe,
Secretary

3. *Copy of a letter from Professor Bernal.*

Birkbeck College Research Laboratory,
21 Torrington Square, W.C.1.
13th September, 1949.

D. N. Lowe, Esq.

DEAR SIR—I learned with surprise while still in Moscow, of the action of your Council in suspending my nomination to that body. I regret that the Council saw fit to release their decision to the press before communicating directly with me. This inevitably resulted in a publicity, much of it biassed and ill-informed, which must have detracted from interest in the real business of the Association.

In answer to your letter which informed me of these facts, I am enclosing the full text of my speech to the Peace Congress in Moscow. Earlier accounts which had reached this country, were either shortened versions or paraphrases for which I cannot be held responsible. It may be, therefore, that isolated passages whose sense requires their context, were those that gave rise to the apprehensions of members of Council. If so the misunderstandings can readily be cleared up.

If, however, exception was taken to the general nature of the speech, I may be justified in feeling that political rather than scientific considerations were allowed to enter into the discussion. The views in the speech are essentially those which I have expounded many times in public meetings at home and abroad and are to be found in many of my published writings. Never before have they been considered to justify action by any scientific body. They represent conclusions honestly arrived at which I am prepared to sustain by arguments based on verifiable facts.

I have nothing to withdraw of what I have said. I still believe that the peace and happiness of the world is better secured by establishing friendly relations between people whose governments may differ on economic theory, than by piling up armaments and dividing the world into two irreconcilable camps. I do not feel that this can be out of keeping with the policy of the Association which only two years ago had as its motto the turning of ' Swords into Ploughshares.' Nor do I consider out of place a just tribute to an ally who sacrificed millions of lives in our common struggle against Fascism. I know that many persons on the Council will not agree with these sentiments, but, as stated in your letter, political statements are no official concern of the Council.

There is, however, in the reports of my speech which first reached this country, one passage on which a genuine misunderstanding may have arisen. I can assure the Council that it was never my intention either to state or to imply that the scientists responsible for the detailed direction of research in this or any country were haters of peace. Such a statement would be palpably absurd and I am surprised that my colleagues should ever imagine that I should make it.

My remarks, as the context shows, referred to the general economic and political direction of science. In view of the vast expenditure of money and manpower in the United States and Britain on research for the production of such inhuman weapons as atomic bombs and radioactive and bacterial poisons, I feel my statement is by no means an exaggeration.

Whether or not these views are those to which the Council would subscribe seems to me irrelevant. I had never supposed that unanimity on questions of general politics was either required or desirable in such a body as the British Association.

I trust that these remarks have made my position quite clear.

Yours faithfully,
J. D. Bernal

4. *Full text of speech delivered by Professor J. D. Bernal on August 27, 1949, at the conference of the Soviet Partisans for Peace in Moscow.*

COMRADES AND FRIENDS—I feel most honoured to greet on behalf of the World Federation of Scientific Workers this congress

of the great soviet peoples united in the defence of peace. Scientists have a particular responsibility for peace because their work has contributed so much in the past to the waging of war. This evil use of science has never before been developed to the extent that it has now where in the general decay of the capitalist system war remains the last but still most profitable investment of the monopolists. The direction of scientific research is increasingly tuned to war uses. It is radar, long range rockets, the atomic bomb, radioactive poisons and the last perversion of science in bacterial warfare that now occupy the thoughts of men who could use their knowledge for peaceful construction. For now in capitalist countries the direction of science is in the hands of those who hate peace, whose only aim is to destroy and torture people so that their own profits may be secured for some years longer. They show this by their choice of weapons, not those of combat against equally armed opponents but weapons of mass destruction for destroying houses and fields for poisoning women and children. These are not the weapons which win wars as my colleague and friend Prof. Blackett has shown in his book on the atomic bomb. It was not high explosive and fire bombs that broke Nazi Germany, it was the heroic Red Army, it was not the atomic bomb that defeated Japan, but the knowledge of the overwhelming strength of the Soviet Union. No—these weapons are thought of by capitalists as a way of fighting wars by remote control, the push-button war. It is ludicrous yet disgusting to think of General Bradley's open boast of having carefully selected the cities of the Soviet Union for his targets, cities built and rebuilt with such energy and loving care by their people after they had saved the rest of the world from the horrors of fascism.

What hatred and what fear of the people is shown by such war makers. And yet they know these methods will fail. That is why they are trying to drive the peoples of Western Europe to slaughter in the name of the Atlantic Pact.

In all countries still in the capitalist world scientific workers have become aware of the way in which they are being used to intensify the horrors of war. The international movement of protest has spread swiftly. The World Federation of Scientific Workers now representing 30,000 scientists in 15 countries is under the presidency of that great scientist and partisan of peace Prof. Joliot Curie who was the president of the Peace Congress in Paris and the chairman of the Permanent Committe of our movement. It has steadily fought against the perversion of science for war.

This perversion has reached fantastic dimensions. In Britain more than 60% of expenditure on science is for war purposes. In the United States more than a billion dollars a year is spent on science, mostly for war, directly or indirectly. And the bad effect does not stop there, the increasing use of science for war imposes also the restriction of secrecy. Not only is the atom a secret but the habits of bacteria and even the size of the earth are becoming military secrets. Soon it will spread to all aspects of science, what the Japanese called the repression of dangerous thoughts. In the United States it will soon be the case that no one who is not and has not always been an enemy of the Soviet Union will be allowed to teach or research in science and Britain will obediently follow suit.

Where science is not used for war it is used for colonial exploitation. In President Truman's Fourth point in his inaugural address he talks of using the superior scientific and technical resources of the United States to assist backward countries and to make them suitable fields for American investment. However profitable to its promoters the people of those countries have as little to hope for as the African people in the Southern States or the workers in S. America who get one tenth of United States' wages.

The fact is that science in the hands of a decayed capitalism can never be employed usefully, it can only lead to increased exploitation, unemployment, crises and war. It is not astonishing that this should produce in capitalist countries a reactionary attitude to science and inside science itself. There is a revival of the concept of pure objective science removed from all practical social utility, an attempt to divorce science from its reponsibility. It is remarkable, however, that this does not restrain its advocates from virulent Anti-Soviet propaganda though it does cause them to pass in silent or open approval the use of science for war. Under capitalism War is poisoning Science. At the same time outside the scientific world there is a move to reject science altogether and to replace it with a mysticism that can easily again turn to the perversions of the Nazis. Already from America has come the call to reduce the population of a world which can lead logically only to an even more scientific variety of Hitler's gas chambers. You know well enough what nonsense this is—it is the greed and cruelty of capitalism itself that has made the world not fit to live in. Once in the hands of the people there is room and food for all. But they do not see it. For the capitalists and their social democratic supporters there is no future to look forward to. They say civilisation is doomed but it is only

capitalism that is doomed. Only under capitalism is it true that science can bring no happiness but only destruction. The scientist has no freedom—he is a slave to masters who have lost their senses.

What is the answer? I see it before me in this hall, in the streets of Moscow blossoming in new parks and buildings, in the gigantic hopeful constructions of the whole of the Soviet Union. I hear it in the speeches of Academician Vavilov, of the president of the Uzbek Academy, in all the speeches from the Soviet Union, from the Peoples' Democracies and from China. There no longer is science the servant of the capitalist, it is the property of the whole people. It is to be understood by the people and used by them for a future of unlimited socially created beauty and happiness.

The Soviet people is strong because it is wise, because it seeks to realise here and now the best dreams of mankind. The strength of the Soviet people lies not only in their own brave hearts but also in the hearts of hundreds of million of oppressed people of the world. For them you are the hope that inspires them to overcome the despair and oppression which is all the capitalist world has to offer.

That is why I am so proud to be able to greet, in the name of the scientific workers and the partisans of peace in the world, the great Soviet people, who by their heroism have saved science and secured its future for mankind and with them their great leader and protector of peace and science, comrade Stalin.

5. *Copy of a letter to Professor Bernal.*

Burlington House, W.1.
4th November, 1949

Prof. J. D. Bernal, F.R.S.

DEAR SIR—At their meeting this afternoon the Council considered the text of your speech in Moscow and the letter of explanation which accompanied it.

They decided by a majority not to re-elect you to membership of the Council and authorised me to issue a press statement, of which I enclose a copy.

Yours faithfully,
D. N. Lowe,
Secretary

6. *Statement issued to the Press on November* 4, 1949.

At the Newcastle Meeting of the British Association, on August 31, notice was taken by its General Committee of press reports of a speech which had been made in Moscow by Professor J. D. Bernal. It was resolved :

> 'That the Council invite Professor Bernal to substantiate or otherwise, the statements represented in the press to have been made by him in Moscow on August 27, and that until that reply were received the nomination of Professor Bernal for membership of the Council should not be proceeded with and that a vacancy on the Council be maintained.'

To the letter sent in accordance with this resolution, Professor Bernal replied by sending the full text of his speech, together with a letter in which he recognised that one passage in the reports which had reached this country left room for misunderstanding, and assured the Council that it had never been his intention either to state or to imply that the scientists responsible for the detailed direction of research in this or any other country were haters of peace. These documents were brought before the Council at its meeting on November 4.

Council recognises the necessity of distinguishing between political statements of its members, with which it has no concern, and statements on the direction and use of science in this country ; and the objection which it took last August was solely to certain statements of the latter kind. These appear in Professor Bernal's version of his speech, no part of which he withdraws, and in the view of Council its objections are not removed by his letter. Accordingly Council has decided not to re-elect Professor Bernal to its membership.

REPORT OF THE COUNCIL TO THE GENERAL COMMITTEE, 1948–49

(Approved by the General Committee on August 31, 1949)

Obituary

1. Since the last report the Association has suffered the loss of the following office bearers and supporters :

Dr. J. A. Bowie
Mr. Edward Cadbury
Dr. Philip H. Cowell, F.R.S.
Sir W. R. Dunstan, K.C.M.G., F.R.S.
Prof. Beatrice Edgell
Sir John Fryer, K.B.E., F.R.S.
Prof. W. Garstang
Prof. E. J. Garwood, F.R.S.
Mr. W. M. Heller
Prof. J. Hendrick
Mr. J. Hornell
Prof. F. S. Kipping, F.R.S.
Prof. P. E. Newberry
Sir Clifford Paterson, O.B.E., F.R.S.
Prof. G. Potts
Dr. Mabel C. Rayner
Prof. S. H. Reynolds
Dr. G. Scott Robertson
Sir Robert Robertson, K.B.E., F.R.S.
Rev. J. P. Rowland

Relations with other Institutions

2. Representatives of the Association were appointed by the Council as follows :—

Association of British Chambers of Commerce. Mr. M. G. Bennett and Prof. C. B. Fawcett were appointed to attend meetings of the Council and advise on the place of Science in Commerce. Mr. Bennett accompanied the British delegation to the 1948 Empire Congress of Chambers of Commerce, in Johannesburg.

British Association Dundee Trust. Mr. M. G. Bennett.

French Association for the Advancement of Science, Annual Meeting at Clermont-Ferrand, 1949. Dr. Edward Hindle.

International Union for the Protection of Nature. Dr. G. F. Herbert Smith represented the Association at a meeting at Fontainebleau in September 1948, when Union was established.

National Committee for Geodesy and Geophysics. Prof. Harold Jeffreys.

National Foundation for Adult Education, Committee on Science in Adult Education. Prof. Winifred Cullis and Dr. J. C. Maxwell Garnett. Second Annual Conference at Buxton. Prof. Winifred Cullis.

3. The Association was represented at the Jubilee Celebrations of the Polish Academy of Science and Letters by Sir John Russell and Sir Harold Spencer Jones. An address of congratulation was sent from the Association and the Academy presented to the Association a medal which was struck to commemorate the celebrations.

4. The Officers have kept in touch with colleagues in other Associations for the Advancement of Science and representatives of those Associations will be entertained at Newcastle. In view of his long connection with the Australian and New Zealand Association, Sir David Rivett will be a particularly welcome visitor.

5. During the year the Council have given attention to a proposal by the French Association that there should be established a World Federation of Associations for the Advancement of Science. Conversations with the Officers of other Associations are continuing. In the meantime, the Council have learned with pleasure that Associations for the Advancement of Science have been founded on the British model in Brazil, and that contact has been renewed with the Associations in Italy, Portugal and Spain.

6. The Council report that, in order to extend the international contacts of the Association, it has been decided to invite each of the constituent Unions of the International Council of Scientific Unions and the new Union for the Protection of Nature to send representatives to the Annual Meeting, beginning with the meeting in Newcastle.

7. Eight members of the Council are members of the British Committee for Co-operation with UNESCO in the Natural Sciences, two being appointed by the Council and six being members in other capacities. The Association has thus been well represented in this field of international co-operation. The General Treasurer represented the Association at an international discussion on Science Clubs which was held at Unesco House in Paris on July 15 and 16.

Finance

8. The General Treasurer has kept the Council informed of the state of the Association's finances and his Statement and Account for the financial year ending on March 31, 1949, will be submitted to the General Committee.

Future Meetings

9. The Council submit with endorsement a proposal by the Local Executive Committee that the Birmingham Meeting in 1950 be held during the period August 30–September 6.

10. The Council have received invitations from the following cities : Edinburgh in 1951, Belfast in 1952, Liverpool in 1953.

In view of the need to plan ahead for 1951, the Festival of Britain Year, the Council accepted the invitation from Edinburgh and provisionally determined the dates as August 8–15.

The invitations from Belfast and Liverpool have been cordially received by the Council and all three invitations are submitted to the General Committee for approval.

Officers and Council

11. *President*, 1950.—The Council's nomination to the office of President of the Association in the year 1950 is Sir Harold Hartley, K.C.V.O., C.B.E., F.R.S.

12. *President*, 1951.—In view of the special circumstances in which the Meeting in 1951 will be held the Council recommend that the President for that year be now appointed and nominate H.R.H. the Duke of Edinburgh.

13. *Chairman of Council.*—Under Regulation 3 the Council appointed Dr. C. Tierney as Chairman of Council in 1946 for a period of not more than 5 years. On June 3, 1949 the Council learned that for health reasons Dr. Tierney wished to relinquish this office, and accepted his resignation with regret.

14. *General Officers*, 1949–50.—The Council recommend that the present Officers be reappointed :

General Treasurer : Mr. M. G. Bennett.

General Secretaries : Dr. Edward Hindle, F.R.S., and Sir Richard Southwell, F.R.S.

15. *Other members of Council.*—The Council has lost from its membership Prof. H. H. Read, F.R.S., by retirement, Mr. James Hornell who died in February and Prof. C. B. Fawcett, who resigned on taking up a temporary appointment in the United States of America. Dr. A. E. Trueman, F.R.S., Mr. M. C. Burkitt and Prof. L. Dudley Stamp, C.B.E., respectively were co-opted in their stead.

The members retiring under Statute III, 3, are : Prof. W. E. Le Gros Clark, F.R.S., Dr. C. D. Darlington, F.R.S., Sir Charles Darwin, K.B.E., F.R.S., Dr. H. J. T. Ellingham and Dr. C. Tierney.

The Council nominate for appointment : Sir Alfred Egerton, F.R.S., Dr. Ezer Griffiths, F.R.S. and Dr. C. Tierney, leaving two vacancies in the ordinary membership to be filled by the General Committee without nomination by the Council. If the Council's nominations are approved the remaining places should be filled by representatives of Sections H and K.

The full list of nominations of ordinary members is as follows :—

Sir Edward Appleton, G.B.E., K.C.B., F.R.S.
Prof. F. Balfour-Browne
M. C. Burkitt
Prof. David Burns
Ritchie Calder, C.B.E.
Wing-Comm. T. R. Cave-Browne-Cave, C.B.E.
Prof. Winifred Cullis, C.B.E.
Sir Alfred Egerton, F.R.S.
Dr. K. G. Fenelon
Prof. P. Sargant Florence
Dr. J. C. Maxwell Garnett, C.B.E.
Dr. Ezer Griffiths, F.R.S.
Dr. O. J. R. Howarth, O.B.E.
Prof. E. H. Neville
Sir William Ogg
Dr. S. J. F. Philpott, M.C.
Lord Rennell of Rodd, K.B.E., C.B.
Sir John Simonsen, F.R.S.
W. O. Lester Smith, C.B.E.
Prof. L. Dudley Stamp, C.B.E.
Dr. C. J. Stubblefield, F.R.S.
Dr. H. Hamshaw Thomas, M.B.E., F.R.S.
Dr. C. Tierney
Dr. A. E. Trueman, F.R.S.
Prof. R. G. White
Dr. H. E. Wimperis, C.B., C.B.E.
Prof. A. W. Wolters

16. *Honorary Auditors*, 1949–50. — The Council nominate : Dr. H. S. Rowell, O.B.E., and Mr. R. S. Whipple.

General Committee

17. The following have been admitted as members of the General Committee on the nomination of Sectional Committees :—

Section A : Dr. A. Hunter.
Section B : Dr. I. J. Faulkner.
Section C : Prof. T. S. Westoll, Prof. L. R. Wager, Dr. C. T. Trenchman.
Section E : Prof. H. C. Darby.
Section H : Mr. Adrian Digby.
Section I : Dr. D. P. Cuthbertson.
Section J : Dr. Hilda Oldham.
Section K : Dr. P. W. Richards, Prof. C. G. C. Chesters.
Section L : Mr. N. F. Sheppard.

Research

18. Following the Brighton Meeting the Council, on the recommendation of Sections, appointed 19 Research Committees (*Advancement of Science*, Vol. V, No. 20, p. 355). From the funds under their control the Council have approved the following grants to 15 of those Committees :—

Committee	*Section*	*Grant* £	*Fund*
Critical Sections	C	20	Hobson
Plymouth Laboratory	D	50	Caird
Zoological Record	D	50	,,
Biology in the School Curriculum	DK	5	,,
Freshwater Biological Station, Windermere	DK	50	Musgrave £25 Caird £25
Naples Station	DK	50	Caird
Cytology and Genetics	DK	5	Haydock
Geographical Terminology	E	5	Caird
Revival of Geography in nineteenth Century	E	5	,,
Urban Geography	E	5	,,
Inter-Tropical Africa	EH	5	,,
Kent's Cavern	H	10	,,
Derbyshire Caves	H	25	,,
Ainu of Japan	H	25	,,
Notes and Queries in Anthropology	H	25	,,

19. *Notes and Queries in Anthropology*.—The Council report that they have transferred to the Royal Anthropological Institute full responsibility for the work hitherto sponsored by the Association and undertaken by a Research Committee on Notes and Queries in Anthropology.

From 1835 Committees of the Association worked on various branches of anthropology and ethnology, and in 1874 there was published the first edition of *Notes and Queries in Anthropology*. Revised editions appeared in 1892, 1899, 1912 and 1929. The material for the text was collected, written and edited by members of the Association ; the financial responsibility was borne by the Association, and the Royal Anthropological Institute acted as publishers.

During the past year material for a 6th (Revised) Edition was completed. On the recommendation of Section H, the Council reviewed the position and agreed that, since most of the work had recently been undertaken by Fellows of the Royal Anthropological Institute, it would be appropriate for the Royal Anthropological Institute to sponsor the 6th and any future editions. An arrangement to this effect has been made.

The Council wish to record their sincere appreciation of the devoted service of past and present members of the Association in producing and maintaining this classic work.

Lectures and Meetings

20. Two of the three memorial lectures maintained by the Association are due to be delivered in 1949. The Council has appointed Prof. Herbert Dingle to deliver the Norman Lockyer Lecture in Birmingham.

21. The Division for Social and International Relations of Science has not arranged any Conferences between the Annual Meetings, but has arranged a public session during the Newcastle meeting, on ' Food and People,' the subject chosen by UNESCO for discussion in member States.

Publications

22. *The Advancement of Science* has been published at regular quarterly intervals and has now reached a circulation of 3,000 copies.

23. The Council report with pleasure that the initiative of colleagues in Newcastle and a generous grant from the Local Fund have made it possible to add another volume to the pre-war series of Scientific Surveys of the regions of annual meetings.

Resolutions and Recommendations

24. The Council received and considered a number of resolutions after the meeting at Brighton.

(*a*) *That progress towards a National Atlas be reviewed.* On this the Council report that, by agreement of all parties concerned, the Royal Society undertook to request the Government to approve a scheme for a National Atlas, and that the response has not, so far, been favourable.

(*b*) *That the pre-war Journal of Abstracts be restored as soon as possible.* After consultation with Recorders of Sections the Council approved as an experiment for one year the inclusion of 100-word abstracts in the Timetable of the Newcastle Meeting.

(*c*) *That the Council should consider whether any steps could be taken to remedy the shortage of scientific and technical books.* The Council appointed a Committee to study this question and has received a report which has been published in *The Advancement of Science* (No. 22, p. 117). The report summarised the investigations made by the Committee with special reference to ' post-graduate ' memoirs and recorded the conclusions that the shortage of such books was due to shortage of skilled labour for binding, that there was little saving of labour through binding in paper as against cloth, and that the only possible alternative, of distributing loose sheets, was unlikely to be sufficiently popular with users to justify the establishment of special arrangements for distribution. The Council hope that publication of this report will dispose of some popular misapprehensions on this subject.

Corresponding Societies

25. The Council appointed a Committee to suggest ways in which the Association might help Corresponding Societies and strengthen the Conference of Delegates. In consultation with the Corresponding Societies Committee a memorandum was prepared and, with Council's approval, was circulated to Corresponding Societies and others. The memorandum listed the following actions which the Association was prepared to undertake if desired :

To enter into correspondence with any local scientific society whose objects are in keeping with those of Association ;

To welcome delegates from all Corresponding Societies at Annual Meetings of the Association ;

To exchange publications ;

To consider proposals for improvement of the dissemination of information reported to local scientific societies, whether by publication or otherwise ;

To consider recommendations from the Conference of Delegates of Corresponding Societies on any matters affecting the interests of local societies, and to take appropriate action in consultation with any other national (or regional) body concerned ;

To arrange joint meetings of members of local societies and selected members of the Association at times other than the Annual Meetings, and particularly in towns and in areas in which Annual Meetings of the Association are not normally held ;

To promote and advise on the preparation and publication of books, pamphlets and bibliographies of the regional survey type ;

To promote temporary exhibits or exhibitions useful to local museums and local societies (in consultation with appropriate national bodies) ;

To promote local contributions from local scientific societies to such national research undertakings as the Domesday Critical Survey, the Land Utilisation Survey and the National Atlas.

26. The following have been admitted as Corresponding Societies : The Devonshire Association for the Advancement of Science, Literature and Art, the Scottish Field Studies Council, and the Botanical Society of Edinburgh.

Drafting of Programmes

27. Following discussions at the Brighton Meeting, the Council have reviewed the procedure for arranging the programmes of the ensuing Annual Meeting, and have made a number of changes designed to accelerate the drafting of programmes and to strengthen the consultation between Sections.

Hitherto it has been usual for the Officers of Sections to be appointed by the Council in November, and for programme drafting to begin with the meetings of Sectional Committees in January. The Council now propose to meet on the last day of the Annual Meeting to appoint Presidents of Sections, Recorders and Secretaries so that consultations on programmes for the ensuing meeting can take place without further delay. It is also proposed to arrange a meeting of Recorders in London in October or November to consider possible programme topics, with special reference to subjects suitable for joint sessions. In this way it is hoped that concrete proposals (including any recommendations which the Council may wish to make) can be prepared for consideration by Committees of Sections at their joint and separate meetings in January.

The Council have also reviewed considerations affecting the content of the programme of an annual meeting and their recommendations to the Sectional Committees include the following :—

Most papers (except, perhaps in mathematics) should be capable of being understood by intelligent laymen (including scientists who visit Sections dealing with subjects other than their own).

Prominent places in programmes should be given to joint sessions on the growing points of science (*e.g.* genetics, ecology and biochemistry), and to reviews of advances in particular branches of science.

A single theme for a whole annual meeting is not normally practicable though it may be possible and useful on special occasions. When practicable, however, a theme for a proportion of the programme might be arranged and should normally be associated with the subject of the Presidential Address.

Membership

28. Having been advised by the General Treasurer that the income of the Association for general purposes was insufficient to maintain current expenditure, the Council appointed a committee to consider and report on the possibility of increasing income from membership subscriptions. The Council received and approved a report of which the following is a brief summary.

The Committee recommended that no change be made in the rate of subscriptions. The possibility of increasing the subscription for members, associate members, corporate members and student members, was considered but it was thought that, in present

circumstances, any increase would act as a deterrent to the recruitment of new members. The possibility of reducing the life composition fee (and thereby making life membership more attractive) was also considered. The Committee found that, representing 12½ years' purchase of full privileges, the fee was lower than that charged by comparable bodies, and no reduction appeared to be practicable. The Committee recommended an active publicity campaign to retain the interest and support of ephemeral members and to introduce new members to the Association. The report contained detailed proposals for short term and long term publicity.

The Committee's report paid special attention to the desirability of increasing the number of Corporate Members. In dealing with this Section of the report the Council resolved to recommend to the General Committee an amendment to Statute XII (v) which reads as follows :—

'Any British corporate body approved by the Council shall, on an annual payment not less than ten guineas, be entitled to appoint representatives not exceeding five in number to attend the Annual Meeting, and to receive such publications of the Association as the Council shall from time to time determine.'

The Council recommend that the second word 'British' be deleted.

Down House

29. The number of visitors to the Darwin Memorial during 1948 was 3,768, compared with 3,497 in the preceding year; figures during the current year so far indicate a further increase. Visits by parties from societies and schools continue in welcome measure.

The amount of precipitation recorded on the standard raingauge in 1948 was 34·71 ins. It is regretted that both the seismological records and the experimental bed of *Lythrum salicaria* have, at least temporarily, been stopped. The seismographs are in need of repair, and arrangements for the growth of seedlings for the experimental bed could not be made at the John Innes Horticultural Institution last year. The resumption of both activities is under consideration.

During the year one of the paintings by Joseph Wright, placed in the house by the late Sir Buckston Browne, was lent to the British Council for an exhibition abroad.

On the retirement of Professor Brooks from the Chair of Botany in the University of Cambridge, his successor, Professor G. E. Briggs, confirmed the arrangement that the Darwin Library should be housed in the Darwin Memorial.

In spite of all reasonable economies, expenditure on the maintenance of Down House has continued to exceed income from the endowment and from other sources. This remains a serious problem and efforts are still being made to bridge the gap. As the administration of the Trust has recently proved to need the continuous attention of the Officers, the Council have empowered them to perform the functions of the Down House Committee which has been allowed to lapse. The Council have also appointed a Committee to consider and report on proposals for increasing the usefulness of Down House as a scientific centre.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

GENERAL TREASURER'S STATEMENT AND ACCOUNT, 1948–49

In presenting the Association's Balance Sheet and Accounts last year some confidence was expressed that the finances of the Association were well on the way to recovery from the effects of the war. At first sight this year's figures hardly seem to justify that optimism. Unfavourable balances are shown of £1,247 on the General Account, and £720 on the Down House Account, although the remaining Special Funds are in a satisfactory state.

Under the Will of the late Mr. J. R. Solly the Association receives a bequest slightly exceeding £3,000, of which £2,711 appears in the present balance sheet. As the bequest is available for the general purposes of the Association it adds most fortunately to our resources.

Arrangements already reported for transfer to the Royal Society of the Association's responsibility for work on mathematical tables have been completed and the funds previously held by the Association for this purpose, namely the Cunningham Bequest and the Mathematical Tables Fund, are now in the hands of the Royal Society, as the accounts show.

The attached statements show how much the continued solvency of the Association depends upon annual membership, for the main reason for the deficit on General Account this year was the small local membership at the Brighton Meeting. It is perhaps not unduly optimistic to have confidence that the membership at future meetings will be restored to higher levels. The mere restoration of membership numbers will not, however, be adequate to balance our accounts in the future, because of increasing costs in many directions. A Committee of Council has had this matter under examination and a number of ways of increasing income have been planned. This subject is referred to in more detail in the Report of Council.

One of the ways in which members can materially help the finances of the Association is by covenanting to pay their subscriptions from their taxed income for a period of seven years. It has been established that in such cases the Association, ranking as it does as a charity, may recover the income tax which has been paid by the subscriber. In this way, without any further burden falling upon the subscribers, the income from each membership can be increased by over 80 per cent. It is hoped that a large number of members will welcome this means of helping the Association. At the same time a drive to augment the number of members, individual and corporate, is being made.

The adverse balance on General Account might have been much greater had the permanent office of the Association not been conducted with the utmost economy and even some inconvenience to its occupants. All members of the Association have ample reason to be most grateful to the permanent staff for their loyal and self-sacrificing work.

Attention has in recent years been drawn to the accumulating excess of expenditure over income on the Association's Darwin memorial property, Down House. As a result of the very rigid economies that have been effected the deficit this year is less than was expected. Nevertheless Council has deemed it necessary to use some of the capital of the Endowment Fund to repay the amounts advanced from General Funds. It is unfortunate that this encroachment on capital has been necessary. It brings into sharper focus the need to find some solution to the Down House problem consistent with the wishes of the donor, the late Sir George Buckston Browne, ' that in times to come the labours of the late Charles Darwin on behalf of truth will be esteemed ever higher and that men will desire to know the home in which he lived and laboured.'

Proposals for the use of Down House as an active educational and cultural centre are under examination. It is hoped these will serve the original purpose and at the same time solve the financial problem, but the data are not yet available to submit a definite scheme.

The broad picture of the financial situation is then as follows. There has been some set-back this year due to a drop in membership, which it is expected is but temporary. As against this must be counted the steps being taken to increase membership (an activity in which it is hoped all members will participate), to increase the income from subscriptions by the use of seven year covenants, and the eventual solution of the Down House problem by one or other of the means under consideration. Unremitting application to these progressive measures, and the continued support of the members should, it is felt, establish soundly the financial basis of the Association, and the restrained optimism expressed in last year's report as to the recovery of our finances from the effects of the war is therefore considered to be justified.

M. G. Bennett,
General Treasurer.

Balance Sheet, 31st March, 1949

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

LIABILITIES

	£ s. d.	£ s. d.
GENERAL PURPOSES :—		
Sundry Creditors	633 13 3	
Amounts received in advance for publications	143 10 2	
Membership and Associateship subscriptions in advance	125 15 0	
		902 18 5
Accumulated Fund		
As per last Account	42,783 5 5	
Add Profit on repayment of Great Indian Peninsula Railway Annuity	814 9 10	
	43,597 15 3	
Less Excess of Expenditure over Income for the year	1,247 8 10	
		42,350 6 5
Legacy by Mr. J. R. Solly, 1948		2,711 1 11
Life Membership Compositions		
As per last Account	5,816 7 2	
Add Subscriptions received during year	236 3 2	
	6,052 10 4	
Less Amount transferred to Income and Expenditure Account	7 0 0	
		6,045 10 4
[49,535 14 4]		52,009 17 1
Development Fund		
As per last Account	5,750 3 8	
Add Excess of Income over Expenditure for the year	149 16 4	
[5,750 3 8]		5,900 0 0
SPECIAL PURPOSES :—		
Caird Fund		
Capital	9,928 17 9	
Income and Expenditure Account balance as per last Account	510 18 4	
Less Excess of Expenditure over Income for the year	29 2 8	
	481 15 8	
[10,439 16 1]		10,410 13 5
Mathematical Tables Fund		
As per last Account	319 17 8	
Add Receipts from sales	21 2 6	
	341 0 2	
Less Transfer to Royal Society	341 0 2	
[319 17 8]		- - -
Cunningham Bequest Fund		
As per last Account	1,930 18 2	
Add Excess of Income over Expenditure for the year	35 4 3	
	1,966 2 5	
Less Transfer to the Royal Society:		
Investments 1,756 3 7		
Cash 209 18 10		
	1,966 2 5	
[1,930 18 2]		- - -
Toronto University Presentation Fund		
Capital	178 11 4	
Income and Expenditure Account balance as per last Account	5 7 9	
Less Excess of Expenditure over Income for the year	1 6	
	5 6 3	
[183 19 1]		183 17 7
Bernard Hobson Fund		
Capital	1,093 2 6	
Income and Expenditure Account balance as per last Account	200 17 3	
Add Excess of Income over Expenditure for the year	132 9 1	
	333 6 4	
[1,293 19 9]		1,426 8 10
Leicester and Leicestershire Fund, 1933		
Capital	1,000 0 0	
Income and Expenditure Account balance as per last Account	105 4 11	
Add Excess of Income over Expenditure for the year	30 15 9	
	136 0 8	
[1,105 4 11]		1,136 0 8
[70,559 13 8] Carried forward		71,066 17 7

ASSETS

	£ s. d.	£ s. d.
GENERAL PURPOSES :—		
Investments as scheduled with Income and Expenditure Account, No. 1	51,873 0 8	
Sundry debtors	127 11 1	
Cash in hand	11 4	
Cash at bank	8 14 0	
[A post-war credit certificate for £5 has also been transferred to the Association under Mr. Solly's bequest, and a further sum of approximatly £350 is expected.]		
[49,535 14 4]		52,009 17 1
Development Fund		
Investments (see Income and Expenditure Account No. 2)	5,500 0 0	
Cash at bank	400 0 0	
[5,750 3 8]		5,900 0 0
SPECIAL PURPOSES :—		
Caird Fund		
Investments (see Income and Expenditure Account, No. 3)	9,928 17 9	
Cash at bank	481 15 8	
[10,439 16 1]		10,410 13 5
Mathematical Tables Fund		
Cash at bank, Nil		- - -
[319 17 8]		
Cunningham Bequest Fund		
Cash at bank, Nil		- - -
[1,930 18 2]		
Toronto University Presentation Fund		
Investment (see Income and Expenditure Account, No. 5)	178 11 4	
Cash at bank	5 6 3	
[183 19 1]		183 17 7
Bernard Hobson Fund		
Investments (see Income and Expenditure Account, No. 6)	1,243 2 6	
Cash at bank	183 6 4	
[1,293 19 9]		1,426 8 10
Leicester and Leicestershire Fund, 1933,		
Investments (see Income and Expenditure Account, No. 7)	1,000 0 0	
Cash at bank	136 0 8	
[1,105 4 11]		1,136 0 8
[70,559 13 8] Carried forward		71,066 17 7

Balance Sheet, 31st March, 1949 (*continued*)

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

LIABILITIES (*continued*)

		£ s. d.	£ s. d.
[70,559 13 8]	Brought forward		71,066 17 7
	Radford Mather Lecture Fund		
	Capital	250 0 0	
	Income and Expenditure Account balance as per last Account . 30 1 8		
	Add Excess of Income over Expenditure for the year . . . 6 14 5		
		36 16 1	
[280 1 8]			286 16 1
	Mrs. E. M. Musgrave's Legacy (1944)		
	Balance as per last Account . .	25 0 0	
	Less Grant (see Schedule appended)	25 0 0	
[25 0 0]			- - -
	Arthur Haydock Bequest (1945)		
	Capital	2,215 12 0	
	Income and Expenditure Account balance as per last Account . 172 1 9		
	Add Excess of Income over Expenditure for the year . . . 65 16 9		
		237 18 6	
[2,387 13 9]			2,453 10 6
	Gift (1946) for research in memory of Miss J. R. Corcoran . .		100 0 0
[100 0 0]			
	Down House		
	Endowment Fund as per last Account 21,296 9 5		
	Less Suspense Account transferred 2,129 1 5		
		19,167 8 0	
	Library Fund	10 10 0	
	Sundry Creditors . . .	5 7 7	
[22,852 18 7]			19,183 5 7
[96,205 7 8]			£93,090 9 9

ASSETS (*continued*)

		£ s. d.	£ s. d.
[70,559 13 8]	Brought forward		71,066 17 7
	Radford Mather Lecture Fund		
	Investments (see Income and Expenditure Account, No. 8) .	250 0 0	
	Cash at bank	36 16 1	
[280 1 8]			286 16 1
	Mrs. E. M. Musgrave's Legacy (1944)		
	Cash at bank, Nil		- - -
[25 0 0]			
	Arthur Haydock Bequest		
	Investments (see Income and Expenditure Account, No. 9) .	2,215 12 0	
	Cash at bank	237 18 6	
[2,387 13 9]			2,453 10 6
	Gift for research in memory of Miss J. R. Corcoran—Cash at bank .		100 0 0
[100 0 0]			
	Down House		
	Investments (see Income and Expenditure Account, No. 10) .	19,086 9 5	
	Sundry Debtors	9 4 11	
	Catalogues in stock, at cost . .	58 2 7	
	Cash at bank	9 15 0	
	Cash in hand	19 13 8	
	Suspense Account balance as per last Account . 1,408 2 9		
	Add Excess of Expenditure over Income for the year . . . 720 18 8		
		2,129 1 5	
	Less transferred to Endowment Fund . 2,129 1 5		
		- - -	
[22,852 18 7]			19,183 5 7
[96,205 7 8]			£93,090 9 9

We have examined the foregoing Account with the Books and Vouchers and certify the same to be correct. We have also verified the Balance at the Bankers and the Investments, and have inspected the Deeds of Down House.

Approved:
ROBERT S. WHIPPLE
EZER GRIFFITHS } *Auditors.*

W. B. KEEN & CO., *Chartered Accountants,*
Finsbury Circus House, E.C. 2.
28th July, 1949.

INCOME AND EXPENDITURE ACCOUNTS FOR THE YEAR ENDED 31st MARCH, 1949

No. 1. General Income and Expenditure

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.	£ s. d.
	Investments at cost :		
	£6,648 18s. 2d. Consolidated 2½ per cent. Stock (Inscribed)		5,111 3 0
	£1,252 16s. 2d. Consolidated 2½ per cent. Stock (Registered)		1,000 0 0
	£4,068 19s. 0d. 3 per cent. Savings Bonds 1955/65		4,088 19 0
	£1,808 0s. 0d. 3 per cent. Savings Bonds 1960/70		1,816 1 8
	£18,400 0s. 0d. 3 per cent. Savings Bonds, 1965/75		19,098 11 9
	£52 12s. 7d. 3½ per cent. War Stock (Post Office issue)		54 5 2
	£7,370 19s. 6d. 3½ per cent. War Stock, 1952 or after		7,482 10 9
	£6,768 15s. 7d. 3½ per cent. Conversion Stock, 1961 or after		5,726 8 11
	£4,184 18s. 2d. 2½ per cent. Treasury Stock, 1975 or after		4,184 18 2
	£1,400 0s. 0d. 4 per cent. Funding Loan Stock, 1960/90		1,622 0 0
	£454 11s. 6d. 3 per cent. London County Consolidated Stock, 1956/61		462 2 0
	£981 10s. 0d. 4 per cent. Commonwealth of Australia Stock 1955/70		1,000 0 0
	£125 3s. 9d. 3 per cent. British Transport Stock, 1978/88		125 0 0
	£100 0s. 0d. 3 per cent. Defence Bonds		101 0 3
	[*Value of stocks at 31/3/48, £48,651 6s. 8d.*]	(Value at 31/3/49, £52,776 12s. 7d.)	
[*47,779 13 9*]			£51,873 0 8

EXPENDITURE

	£ s. d.	£ s. d.	
To Heat, Lighting and Power		81 14 2	
„ Stationery (including new duplicator, £105, and filing cabinets, £62 10s. 2d.)		443 4 11	
„ Rent		1 0 0	
„ Postages		308 10 4	
„ Telephone		34 15 5	
„ Insurances		8 11 1	
„ Travelling expenses		466 13 1	
„ Audit for 1947–48		126 0 0	
„ Exhibitioners: Fares	99 7 4		
Less Liverpool University grants	13 10 0		
		85 17 4	
„ Subscription to Parliamentary and Scientific Committee		10 10 0	
„ Hire of meeting rooms		15 18 7	
„ Copying, etc., by outside offices		47 15 10	
„ Lift Inspection and Repairs		26 3 6	
„ Carriage		6 19 3	
„ Reference books, press cuttings, etc.		32 13 2	
„ General expenses		43 17 3	
„ Panels of armorial bearings		11 6 9	
„ Salaries, wages, pensions and National Insurance		3,492 1 11	
„ Printing, etc.—			
"The Advancement of Science"	1,713 1 6		
Miscellaneous	1,005 12 6		
		2,718 14 0	
„ Alexander Pedler Lecture, 1948: Fee		10 10 0	
„ Norman Lockyer Lecture, 1948: Fee		10 10 0	
„ Hospitality, mainly at Brighton meeting (including accommodation of sectional officers, students, etc.)	1,005 18 11		
Less Contributions and donations	268 5 6		
		737 13 5	
[*6,821 7 11*]		8,721 0 0	
„ *Balance, being excess of Income over Expenditure for the year* [*614 15 10*]		– – –	
[*7,436 3 9*]		£8,721 0 0	

INCOME

	£ s. d.	£ s. d.	
By Annual subscriptions		2,910 11 0	
„ Life Compositions: amount transferred on expiry of membership		7 0 0	
„ Sale of Publications	716 12 6		
Less amount transferred to Mathematical Tables Fund	21 2 6		
		695 10 0	
„ Advertisements in B.A. publications		1,090 9 10	
„ Income Tax recovered to 31st March, 1948		20 13 2	
„ Interest on Investments		1,514 18 4	
„ Charges for administration of Special Funds		156 17 7	
„ Donations		53 0 4	
„ Brighton Corporation		1,000 0 0	
„ Surplus on Excursions and Dinners account		24 10 11	
[*7,436 3 9*]		7,473 11 2	
By Balance, being excess of Expenditure over Income for the year		1,247 8 10	
[– – –]			
[*7,436 3 9*]		£8,721 0 0	

No. 2. Development Fund

An appeal for a Development Fund to be used under the direction of the Council, was made at the Annual Meeting at Dundee in 1947 The fund is still open.

	£ s. d.
Investments at cost :	
£2,745 19s. 0d. London County 2½ per cent. Consolidated Stock, 1960/70	2,750 0 0
£2,679 1s. 6d. Bristol Corporation 3 per cent. Redeemable Stock, 1958/63	2,750 0 0
[*Value at 31/3/48, £5,342 2s. 7d.*] (Value at 31/3/49, £5,505 7s. 11d.)	
[*5,500 0 0*]	£5.500 0 0
Cash at bank	£400 0 0

EXPENDITURE	£ s. d.		INCOME	£ s. d.
To Administration	13 13 5		By Contributions	26 15 7
„ Balance, being excess of Income over Expenditure for the year	149 16 4	[*5,750 3 8*]	„ Dividends and Interest	119 14 4
		[*20 15 3*]	„ Income Tax recovered . . .	16 19 10
[*5,770 18 11*]	£163 9 9	[*5,770 18 11*]		£163 9 9

No. 3. Caird Fund

The unconditional gift of Sir James Caird, in 1912, administered by the Council in accordance with recommendations adopted by the General Committee in 1913.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

	£ s. d.
Investments at cost :	
£2,627 0s. 10d. 3 per cent. Savings Bonds 'A,' 1960/70	2,627 0 10
£2,716 16s. 6d. 3½ per cent. War Loan Inscribed Stock	2,516 15 5
£4,282 18s. 9d. 3 per cent. British Transport Stock, 1978/88.	4,785 1 6
[*Value of stocks at 31/3/48, £9,613 6s. 7d.*] (Value at 31/3/49, £9,850 10s. 11d.)	
[*9,928 17 9*]	£9,928 17 9
Cash at bank	£481 15 8

EXPENDITURE	£ s. d.	£ s. d.		INCOME	£ s. d.
To Grants (see Schedule)		332 0 10		By Dividends and Interest	295 3 4
„ Administration charge		33 13 2		„ Income Tax recovered	41 8 0
[*232 14 4*]		365 14 0	[*307 5 10*]		336 11 4
By Balance, being excess of Income over Expenditure for the year		– – –		By Balance, being excess of Expenditure over Income for the year	29 2 8
[*74 11 6*]			[– – –]		
[*307 5 10*]		£365 14 0	[*307 5 10*]		£365 14 0
Grants authorised, not yet drawn :—					
Zoological Record . . .	50 0 0				
Biology in the School Curriculum .	5 0 0				
Naples Zoological Station . .	50 0 0				
Revival of Geography . . .	5 0 0				
Urban Geography . . .	5 0 0				
Inter-Tropical Africa . . .	5 0 0				
Kent's Cavern	10 0 0				
Derbyshire Caves	25 0 0				
Ainu of Japan	25 0 0				
Notes and Queries on Anthropology	25 0 0				
[*288 0 0*]	£205 0 0				

No. 4. Cunningham Bequest

A legacy received by the Association in 1929 in trust under the will of Lt.-Col. A. J. C. Cunningham, for the preparation of new mathematical tables in the theory of numbers ; administered by the Council.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

EXPENDITURE	£ s. d.		INCOME	£ s. d.
To Cost of transfers to Royal Society . .	1 1 0		By Dividends and Interest	29 3 6
„ Balance being excess of Income over Expenditure	35 4 3		„ Income Tax recovered for the year to March 31, 1948	4 14 6
			„ Transfer from General Account : Amount of Income Tax recoverable for the year to March 31, 1949	2 7 3
	£36 5 3			£36 5 3

The Royal Society has assumed the responsibility hitherto borne by the British Association for work in connection with mathematical tables and the balance of the Cunningham Bequest has, with the approval of the executrix, been transferred to the Royal Society, together with the balance of the Association's own Mathematical Tables Fund.

No. 5. Toronto University Presentation Fund

A fund voluntarily subscribed by members present at the Toronto Meeting in 1924. From the income a presentation of two bronze medals each year is made, together with presents of books, to selected students in pure and applied science respectively.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investment at cost :	
	£175 0s. 0d. 3½ per cent. War Stock	178 11 4
[*Value of stock at 31/3/48, £181 11s. 3d.*]	(Value at 31/3/49, £182 0s. 0d.)	
[*£178 11s. 4d.*]		£178 11 4
	Cash at bank	£5 6 3

EXPENDITURE	£ s. d.	INCOME	£ s. d.
To Cost of medals for 1948	2 7 6	By Interest	6 2 6
[*6 2 6*]		[*6 2 6*]	
„ Presents of books, through Toronto University	3 4 3	By Balance, being excess of Expenditure over Income for the year	1 6
„ Administration	12 3	[*29 12 3*]	
[*35 14 9*]	£6 4 0	[*35 14 9*]	£6 4 0

No. 6. Bernard Hobson Fund

The bequest of Mr. Bernard Hobson, 1933; the income to be applied to the promotion of geological research; administered by the Council.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investments at cost :	
	£50 0s. 0d. 4 per cent. Victory Bonds	55 10 5
	£601 9s. 0d. 2½ per cent. Treasury Stock, 1975 or after	601 9 0
	£416 0s. 11d. 3½ per cent. War Stock (Inscribed)	436 3 1
	£178 16s. 4d. Consolidated 2½ per cent. Stock (Registered)	150 0 0
[*Value of stocks at 31/3/48, £1,085 11s. 0d.*]	(Value at 31/3/49, £1,114 13s. 0d.)	
[*1,243 2 6*]		£1,243 2 6
	Cash at bank	£183 6 4

EXPENDITURE	£ s. d.	INCOME	£ s. d.
To Administration	3 12 1	By Repayment by Geological Photographs Committee of Grant (1946)	100 0 0
[*3 7 3*]		[*– – –*]	
„ Balance, being Excess of Income over Expenditure for the year	132 9 1	„ Interest	36 1 2
[*30 5 7*]		[*33 12 10*]	
[*33 12 10*]	£136 1 2	[*33 12 10*]	£136 1 2
Grant authorised, not yet drawn :— Critical Geological Sections	£20 0 0		
[*20 0 0*]	£20 0 0		

No. 7. Leicester and Leicestershire Fund, 1933

The unexpended balance of the local fund for the Leicester Meeting in 1933, presented to the Association, the interest to be used in assisting by scholarships or otherwise students working for the advancement of science; administered by the Council.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investments at cost :	
	£487 2s. 11d. 3½ per cent. Conversion Stock	500 0 0
	£490 5s. 11d. 3½ per cent. War Stock	500 0 0
[*Value of stocks at 31/3/48, £1,017 15s. 0d.*]	(Value at 31/3/49, £1,021 8s. 2d.)	
[*1,000 0 0*]		£1,000 0 0
	Cash at bank	£136 0 8

EXPENDITURE	£ s. d.	INCOME	£ s. d.
To Administration	3 8 5	By Interest	34 4 2
[*3 8 5*]		[*34 4 2*]	
„ Balance, being Excess of Income over Expenditure for the year	30 15 9		
[*30 15 9*]			
[*34 4 2*]	£34 4 2	[*34 4 2*]	£34 4 2

No. 8. Radford Mather Lecture Fund

A gift of £250 received from Mr. G. Radford Mather in 1936 to establish a Fund, the income therefrom to be devoted to meeting the expense of triennial Lectures on Recent Advances in Science and their relation to the Welfare of the Community.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investment at cost :	
	£248 17*s.* 8*d.* 3 per cent. London County Consolidated Stock, 1956/61	250 0 0
[*Value of stock at 31/3/48,* £257 11*s.* 11*d.*]	(Value at 31/3/49, £260 1*s.* 8*d.*)	
[250 0 0]		£250 0 0
	Cash at bank	£30 16 1

EXPENDITURE	£ s. d.	INCOME	£ s. d.
To Lecture fee [21 0 0]	– – –	By Interest [7 9 4]	7 9 4
„ Administration charge [– 14 11]	14 11	„ *Balance, being Excess of Expenditure over Income for the year* [14 5 7]	– – –
„ Balance, being Excess of Income over Expenditure for the year [– – –	6 14 5		
[21 14 11]	£7 9 4	[21 14 11]	£7 9 4

No. 9. Arthur Haydock Bequest

A bequest received in 1945 " for the purpose of original investigation of problems relating to either or both of Geology or Botany as may be determined by the governing body of the British Association."

		£ s. d.
	Investment, as received :	
	£2,090 4*s.* 0*d.* 3½ per cent. Conversion Stock (Registered)	2,215 12 0
[*Value of Stock at 31/3/48,* £2,184 5*s.* 2*d.*]	(Value at 31/3/49, £2,194 14*s.* 2*d.*	
[2,215 12 0]		£2,215 12 0
	Cash at bank	£237 18 6

EXPENDITURE	£ s. d.	INCOME	£ s. d.
To Administration charge [10 15 9]	7 6 3	By Interest	73 3 0
„ Balance, being Excess of Income over Expenditure for the year [97 2 2]	65 16 9	„ Income Tax recovered	– – –
[107 17 11]	£73 3 0	[107 17 11]	£73 3 0

Grant authorised, not yet paid :—	
Cytology and Genetics	£5 0 0
[5 0 0]	£5 0 0

No. 10. Down House

In response to an appeal made in 1927 by Sir Arthur Keith, F.R.S., then President of the British Association, Mr. (later Sir) Buckston Browne, F.R.C.S., acquired the property of Down House, formerly the home of Darwin, and transferred it with an endowment of £20,000 to the Association expressing the wish that it be held in custody for the nation as a memorial to Darwin.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investments at cost :	
	£3,000 Fishguard and Rosslare Railway and Harbours 3½ per cent. Guaranteed Preference Stock	2,139 17 3
	£5,181 12*s.* 4*d.* Consolidated 2½ per cent. Stock (Inscribed)	3,996 15 0
	£5,971 16*s.* 11*d.* Consolidated 2½ per cent. Stock (Registered)	5,000 0 0
	£2,444 15*s.* 10*d.* 3 per cent. Redemption Stock, 1986/96 (Registered)	2,500 0 0
	£7,380 9*s.* 9*d.* 3 per cent. British Transport Stock, 1978/88	5,449 17 2
[*Value of stocks at 31/3/48,* £23,149 0*s.* 5*d.*]	(Value at 31/3/49, £21,858 10*s.* 5*d.*)	
[21,296 9 5]		£19,086 9 5

No. 10. Down House (*continued*)

EXPENDITURE	£	s.	d.
To Wages of Staff	1,061	12	10
,, Rates, Insurance, etc.	119	17	8
,, Electricity	46	2	7
,, Fuel, etc.	128	8	11
,, Drainage	8	14	10
,, Water	21	14	0
,, Repairs and Renewals	73	6	3
,, War Damage repairs (see opposite)	17	16	4
,, Land and Garden: materials and maintenance (see opposite)	35	4	6
,, Donations to village institutions	3	3	0
,, Household requisites, etc.	18	10	4
,, Printing, postage, telephone, stationery	18	13	8
,, Seismology (see opposite)	21	7	10
,, Administration charge	93	17	1
[*2,119 0 5*]	£1,659	9	10

INCOME	£	s.	d.	£	s.	d.
By Rents receivable				85	10	0
,, Income Tax recovered to 31st March, 1948				167	8	0
,, Dividends and Interest				600	15	4
,, Sale of catalogues, postcards and photographs				21	15	0
,, Donations received				3	8	9
,, Seismological Investigations Committee grant from Gray-Milne Trust: 1947–48 account	6	12	1			
1948–49 ,,	21	7	10			
				27	19	11
,, War Damage claim (final)				17	16	4
,, Sale of garden produce				13	17	10
[*1,003 14 6*]				938	11	2
,, Balance, being Excess of Expenditure over Income for the year, carried to Suspense Account				720	18	8
1,115 5 11]						
[*2,119 0 5*]				£1.659	9	10

Schedule

Grants paid to Research Committees, etc., during the financial year to March 31, 1949.

NOTE.—The year indicated in brackets after the title of each committee is that of its original appointment, and the sum, if any, is that previously expended out of grants by the Association.

	£	s.	d.	£	s.	d.
1. PAID OUT OF THE CAIRD FUND (1912)						
Plymouth Laboratory (1886: £1,898 10*s.* 8*d.*)	50	0	0			
Zoological Record (1923: £1,185)	50	0	0			
Mathematical Tables*	100	0	0			
Derbyshire Caves (1921: £408 15*s.* 8*d.*)	25	0	0			
"Notes and Queries on Anthropology:" Committee on re-editing (1931: £31 10*s.*)	25	0	0			
Biology in the School Curriculum (1927)	2	0	10			
Naples Zoological Station (1876: £1,150)	50	0	0			
Geographical Terminology (1937)	5	0	0			
Freshwater Biological Station, Windermere (1930: £1,287 15*s.* 11*d.*) (see also under Musgrave, below)	25	0	0			
				332	0	10
2. PAID OUT OF MRS. E. M. MUSGRAVE'S LEGACY (1944)						
Freshwater Biological Station, Windermere (1930: (see also under Caird Fund, above)				25	0	0
				£357	0	10

*MATHEMATICAL TABLES (1913)

Total grants paid to March 31, 1949:—

	£	s.	d.	£	s.	d.
From Cunningham Bequest	2,895	9	5			
,, Caird Fund	1,821	19	8			
,, Mathematical Tables Fund	192	16	0			
,, General Fund	415	17	6			
,, Royal Society Grant (1933)	50	0	0			
				£5,376	2	7
Amount recovered by sale of tables, etc.:	£	s.	d.			
As last year	1,096	9	0			
Add for year to 31/3/49	42	6	3			
				1,138	15	3
				£4,237	7	4

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